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Record of Decision
Remedial Alternative Selection

Site: Arrowhead Refinery, Duluth, Minnesota

Documents Reviewed

I have reviewed the following documents describing the analysis of cost-effectiveness of remedial alternatives for the Arrowhead Refinery site:

- Arrowhead Remedial Investigation;
- Arrowhead Feasibility Study;
- Responsiveness Summary; and
- Summary of Remedial Alternative Selection.

DESCRIPTION OF SELECTED ALTERNATIVE

- Excavation and onsite incineration of 4,600 cubic yards of sludge and 20,500 cubic yards of contaminated soils and sediments.
- A groundwater pump and treat system to be designed to restore the aquifer and control contaminant migration over a 25-50 year period.
- Extension of nearby municipal water system to replace those private water supplies most likely to be affected by groundwater contamination from the Arrowhead site.
- Proper abandonment in accordance with state well codes of individual wells formerly used as drinking water supplies.
- The selected alternative has total capital cost of $22 million and annual operation and maintenance cost ranging from $130,000 to $180,000. The 30 year present worth is $23-24 million.

DECLARATIONS

Consistent with the Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. §9601 (CERCLA) and the National Contingency Plan, 40 CFR Part 300 (NCP), I have determined that the selected remedy is cost-effective and effectively mitigates and minimizes threats to and provides adequate protection of public health, welfare, and the environment. The state of Minnesota has been consulted and may withhold their concurrence with the approved remedy indefinitely. In accordance with 104(c)(3) of CERCLA, the state may not ensure their ten percent match for construction of the remedy and the continued operation and maintainence of the selected remedy after the first year. Consequently, the design and construction phases, and future actions provisions of predesign investigations for the selected remedy may not be initiated until the State of Minnesota satisfies the provisions 104(c)(3).

September 30th, 1986
Date

Valdas V. Adamkus
Valdas V. Adamkus
Regional Administrator

SUMMARY OF REMEDIAL ALTERNATIVE SELECTION

SITE LOCATION AND DESCRIPTION

The Arrowhead Refinery site is in Hermantown, St. Louis County, Minnesota, approximately eight miles northwest of the City of Duluth. (See Figure 1). The ten acre site is bounded on the north by a surface water diversion ditch, on the south by Miller Trunk Highway (U.S. 53), on the east by Ugstad Road, and the western boundary extends to a culvert under U.S. 53. (See Figure 2).

The site is zoned for commercial use and is situated in a generally flat area with a topographic relief of less than fifteen feet. The surface of the site has relatively poor drainage with peaty wetlands onsite. Current development in the vicinity of the site is a combination of residential, commercial, and public use (Figure 3). Potential receptors that use shallow drinking water wells within 0.3 miles south of the site include 23 residences and 3 commercial establishments. Further south of this area is a wetland which separates it from a partially developed area zoned for public and residential use. A municipal water supply which uses Lake Superior water terminates at the corner of U.S. 53 and Ugstad Road.

SITE HISTORY

Waste oil was reclaimed at the site from 1945 to 1977. The operation generated waste by-products which were discharged into an uncontained

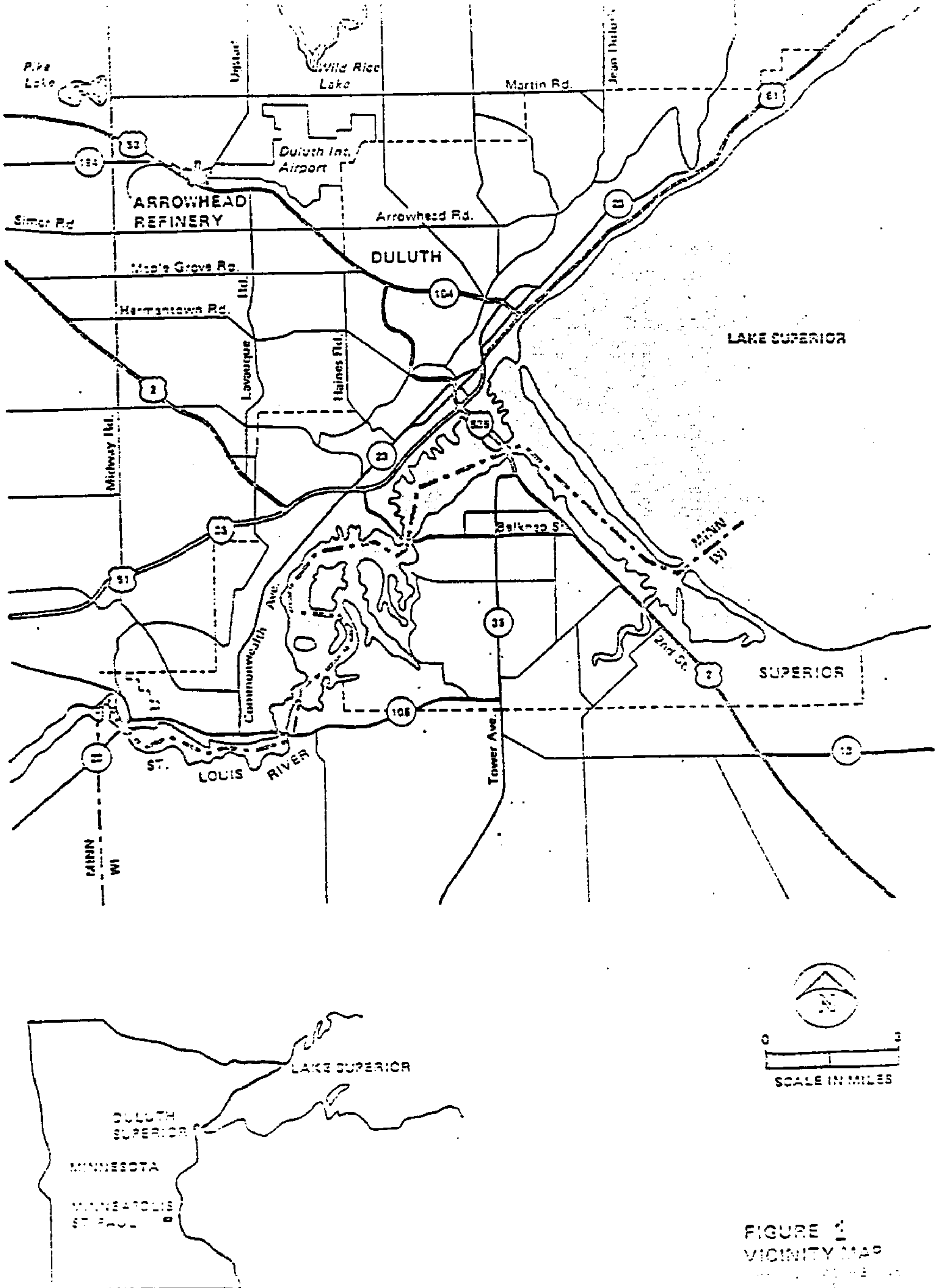


FIGURE 1
VICINITY MAP

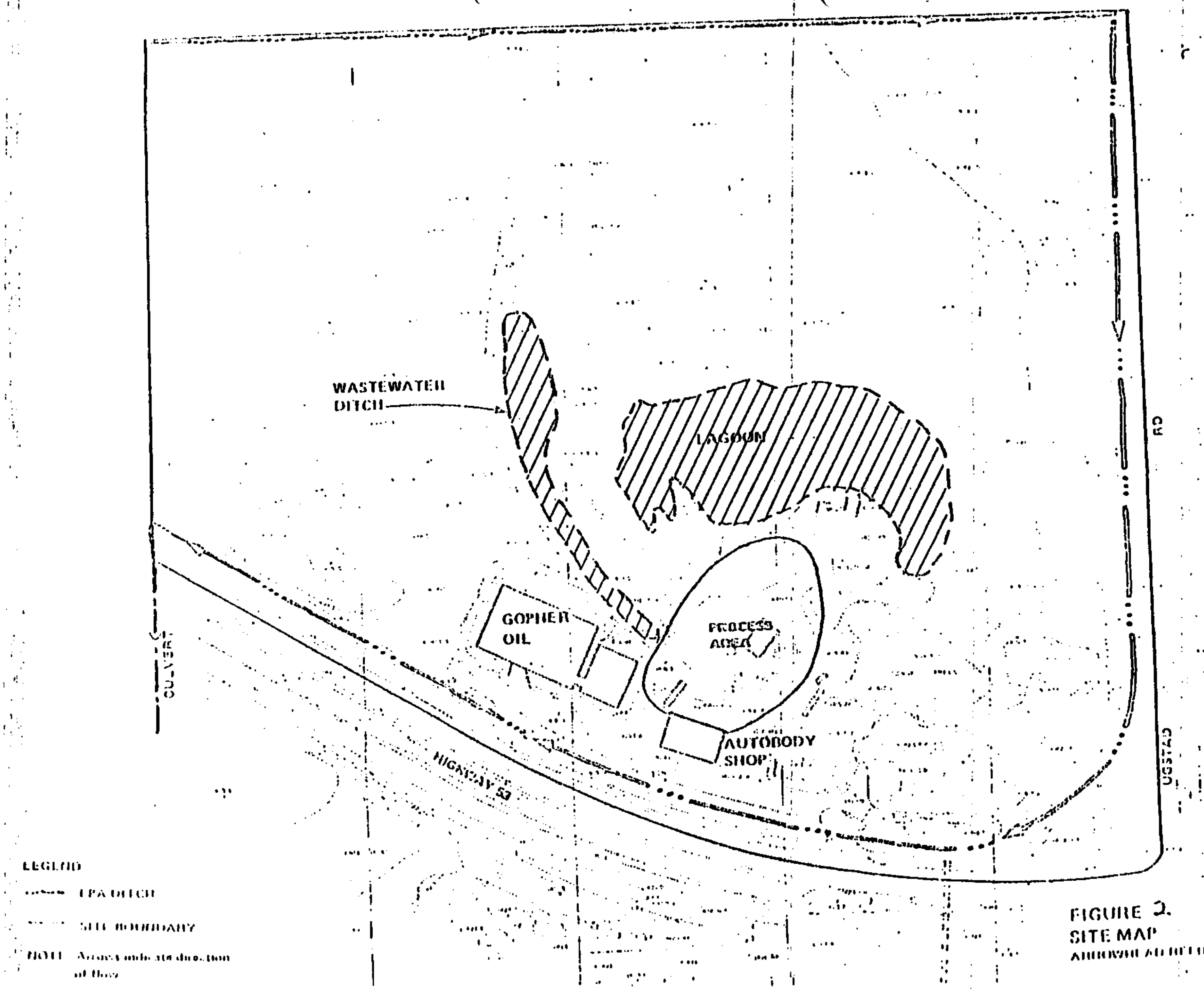
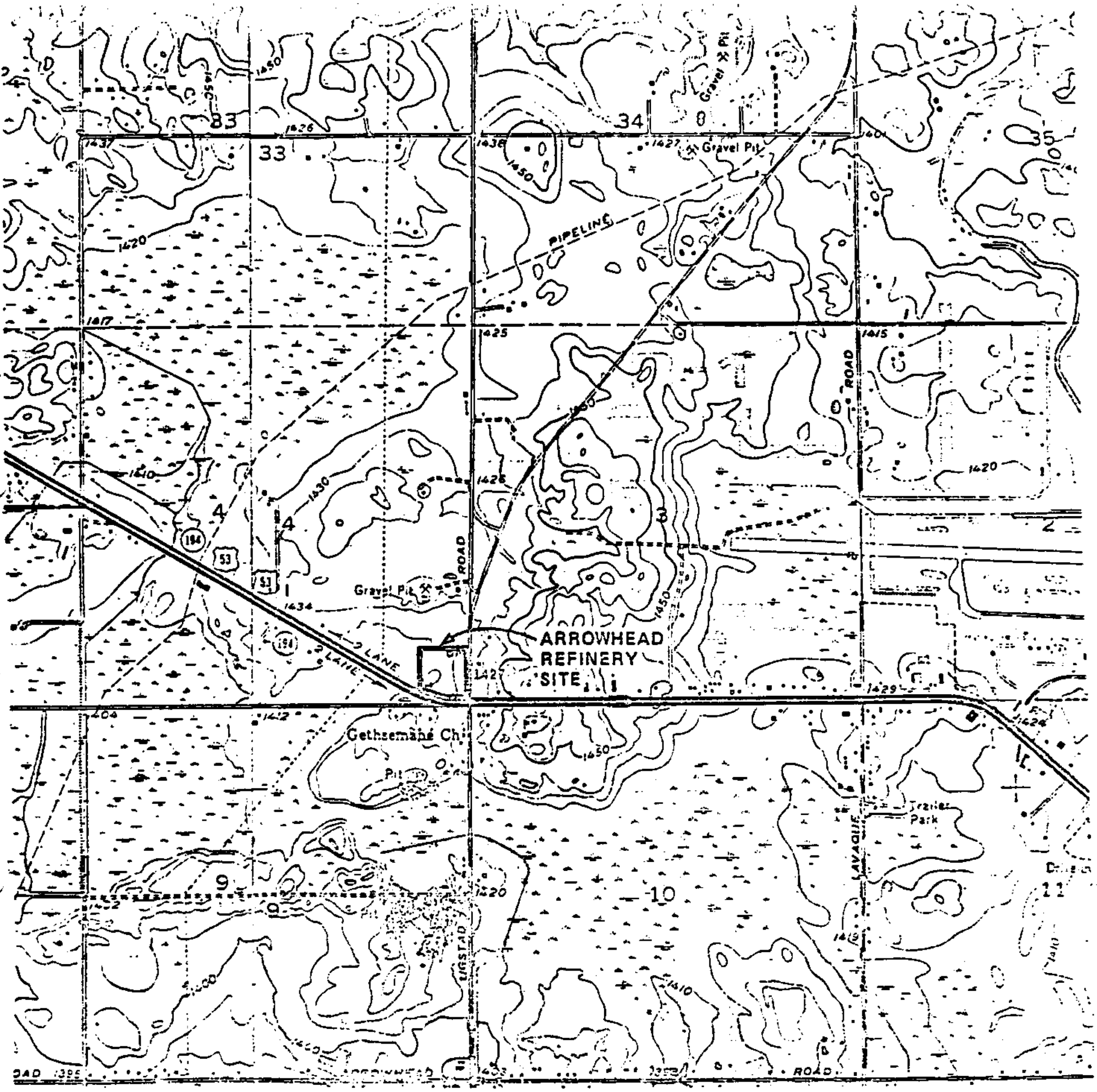


FIGURE 2.
SITE MAP



LEGEND

C-1	COMMERCIAL & LIGHT INDUSTRY
C	COMMERCIAL
R-1	RESIDENTIAL 2½ AC. 200' FRONT
R-3	RESIDENTIAL 1 AC. 100' FRONT
O	OPEN SPACE
M-1	LIGHT INDUSTRIAL
P	PUBLIC

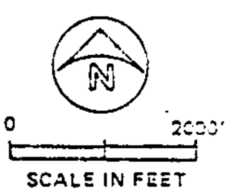


FIGURE 3
ZONING
ARROWHEAD REFINERY RI

2 acre lagoon and a wastewater ditch in a wetland area (Figure 2). Arrowhead Refinery Company, incorporated in 1961, continued the re-refining activities, and also sold recycled name brand oils as well as operating a gas station at one time. The site was reportedly used for retinning milk cans and a trash dump prior to development of the refinery operation. In 1976, the Minnesota Pollution Control Agency (MPCA) ordered Arrowhead to discontinue recycling operations. All Arrowhead activities ceased in 1977. In 1979, the United States Environmental Protection Agency (U.S. EPA), at the request of the MPCA, investigated the environmental effects resulting from past disposal activities. In 1980, U.S. EPA determined that the site was in violation of Section §311 of the Clean Water Act because surface water flowed through the site, transporting contaminants to a nearby wetland area and eventually into navigable waters. In response, a ditch was constructed north and east of the site to help divert surface water around the sludge lagoon. Five monitoring wells were also installed and limited onsite sludge and soil sampling was conducted. This data and subsequent sampling of monitoring wells by the MPCA since 1980 supported the Hazard Ranking Score (HRS) of 43.75. The site was placed on the National Priorities List (NPL) in August, 1983, making it eligible for federal funding under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 U.S.C. §9601 et.seq.

CURRENT SITE STATUS

Remedial Investigation (RI) activities were initiated at Arrowhead in May 1984 and ended in August 1985. Buildings from the Arrowhead Refinery operation were removed. The only buildings presently onsite are a warehouse used by Gopher Oil Company and an auto body shop. Through three phases of field work, 23 additional monitoring wells were installed at various depths at 15 locations (Figure 4), 18 sludge samples were taken at various depths at 8 locations (Figure 5), several subsurface soil samples were taken at various depths at 14 locations (Figure 6), and sediment and surface water samples were taken at 7 locations (Figure 5). Monitoring well samples and water level measurements were taken in December 1984 and June 1985. The Minnesota Pollution Control Agency (MPCA) also split several of U.S. EPA groundwater samples, measured groundwater levels and sampled a limited number of monitoring wells in June 1986. The following briefly describes the RI results.

Hydrogeology

The surface of the site has relatively poor drainage with peaty wetlands existing onsite. The geology can be generally divided into four unconsol-

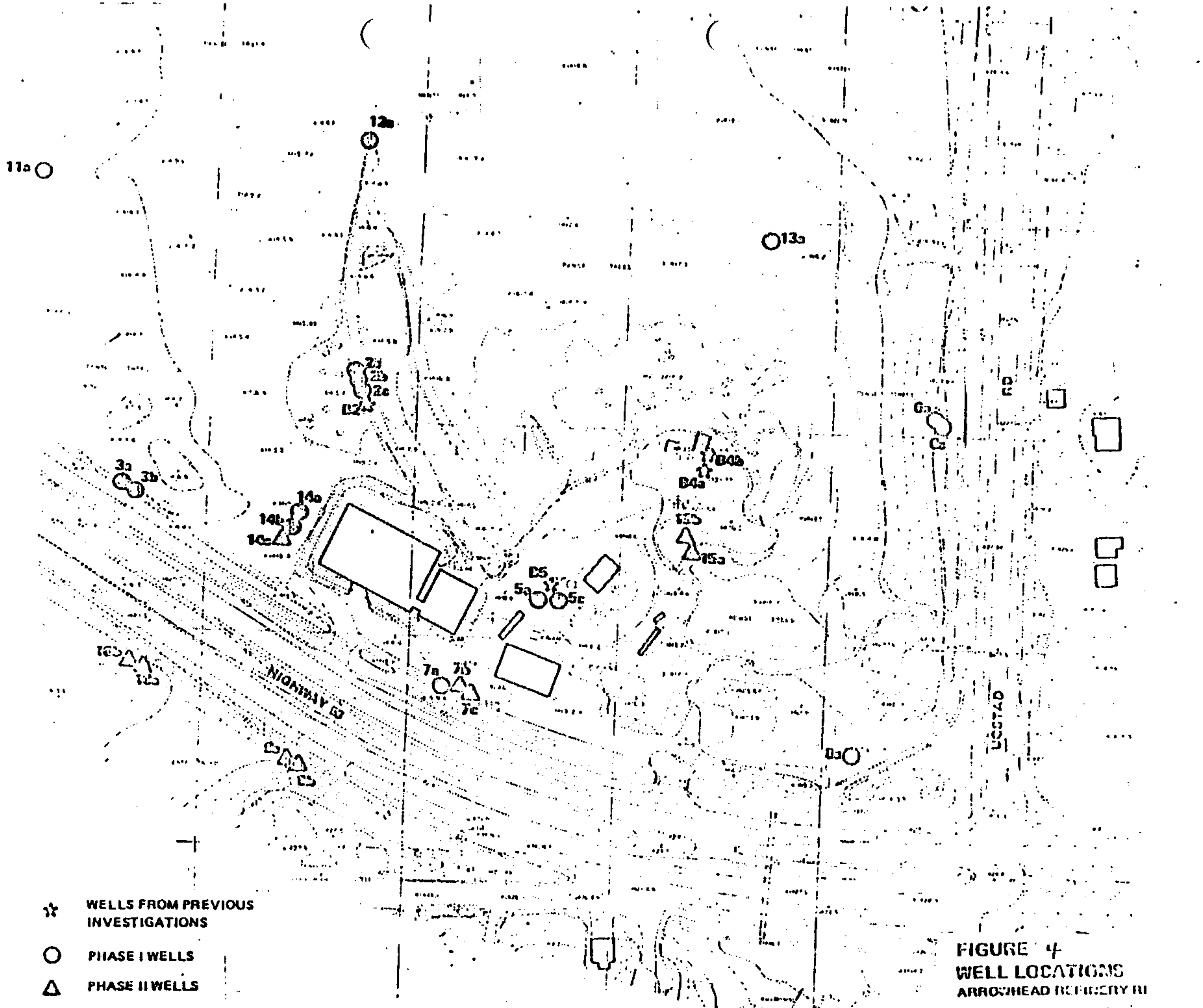


FIGURE 4
WELL LOCATIONS
ARROWHEAD REFINERY RI

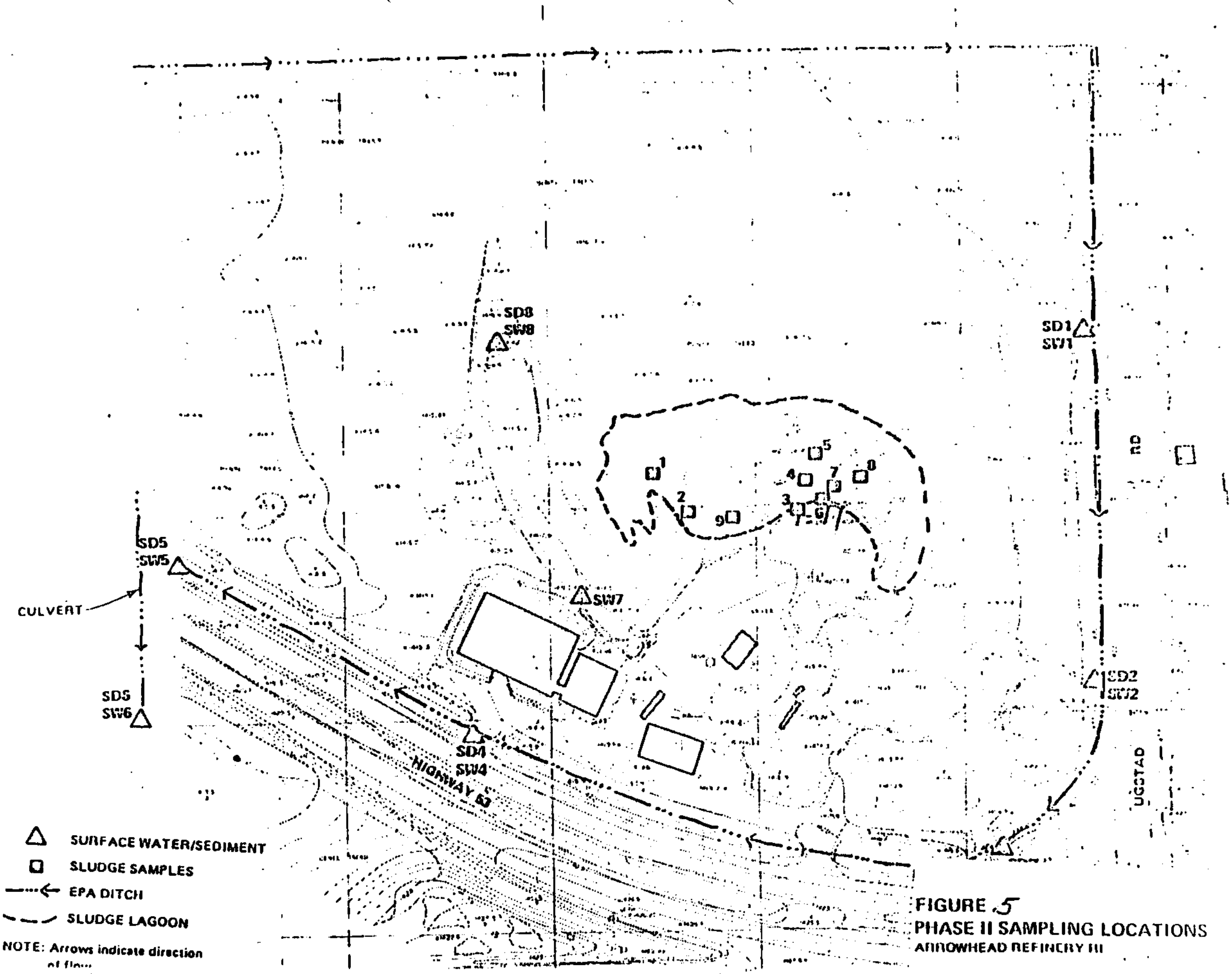


FIGURE 5
PHASE II SAMPLING LOCATIONS
ARROWHEAD REFINERY III

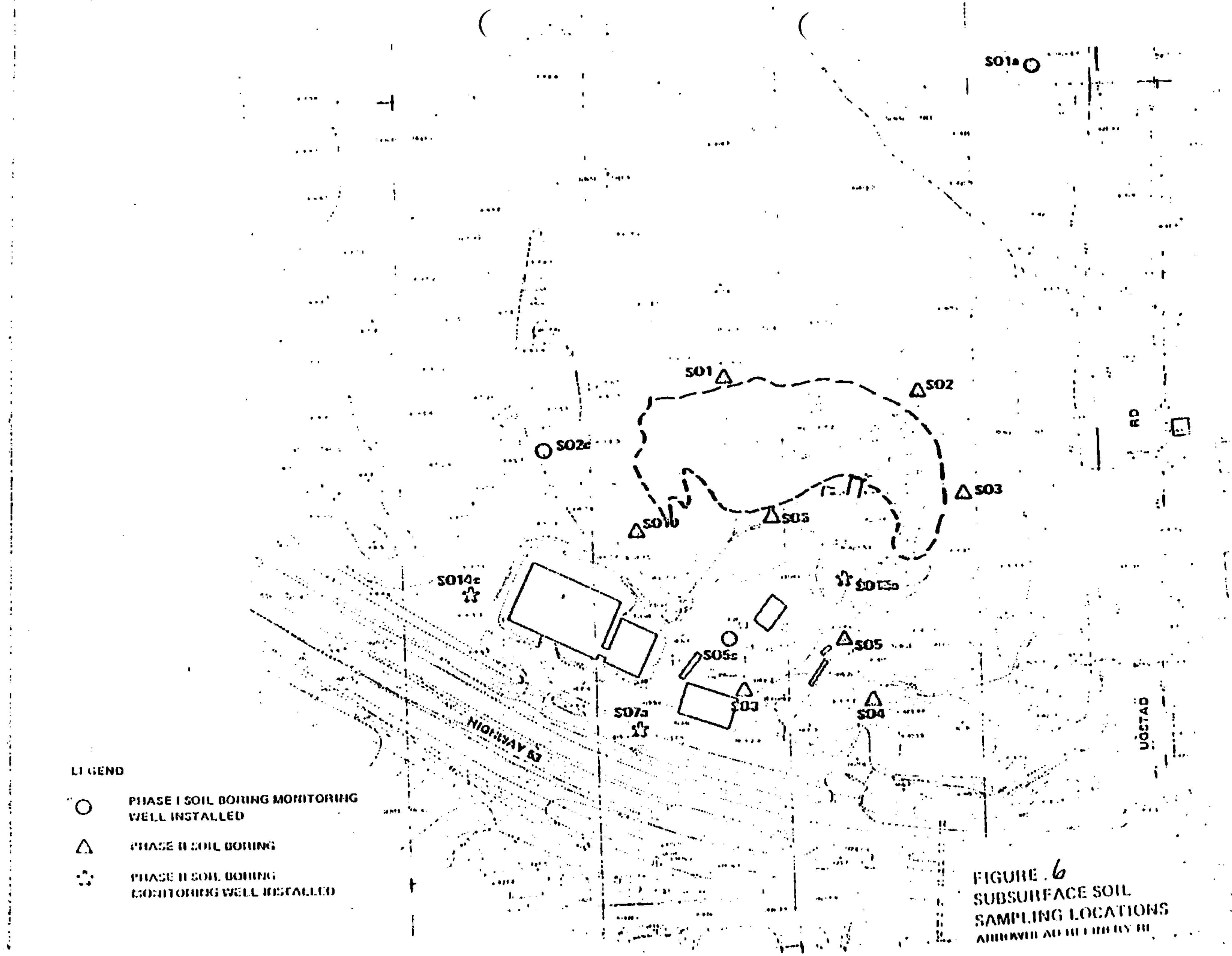


FIGURE . 6
SUBSURFACE SOIL
SAMPLING LOCATIONS
[illegible]

idated layers: 4 feet of fill, 3 feet of peat, 25 feet of outwash, and 12 feet of morainal till. Below the till is fractured gabbroic bedrock. (See Figure 7).

The water table underlying the site is shallow, generally 0 to 4 feet below the ground surface within the peat deposit or overlying fill. Groundwater flow is generally southwest (Figure 8). Average groundwater flow velocities range from 7 feet/year (ft/yr) in the peat layer, 13 ft/yr in an underlying silty clay zone within the outwash layer immediately below the peat, and 27 ft/yr in a sand and gravel zone within the outwash layer below the silty clay zone.

The groundwater elevations also indicate upward vertical gradients in well nests at most locations for a least part of the year. The water level contour map, in conjunction with upward vertical gradients, also indicates that the diversion ditch collects some groundwater for at least part of the year.

EXTENT OF CONTAMINATION

Results from the analysis of several samples collected during the RI document the presence of a variety of priority pollutant compounds. The following briefly describes the RI observations and conclusions regarding the nature and extent of contamination at each operable unit.

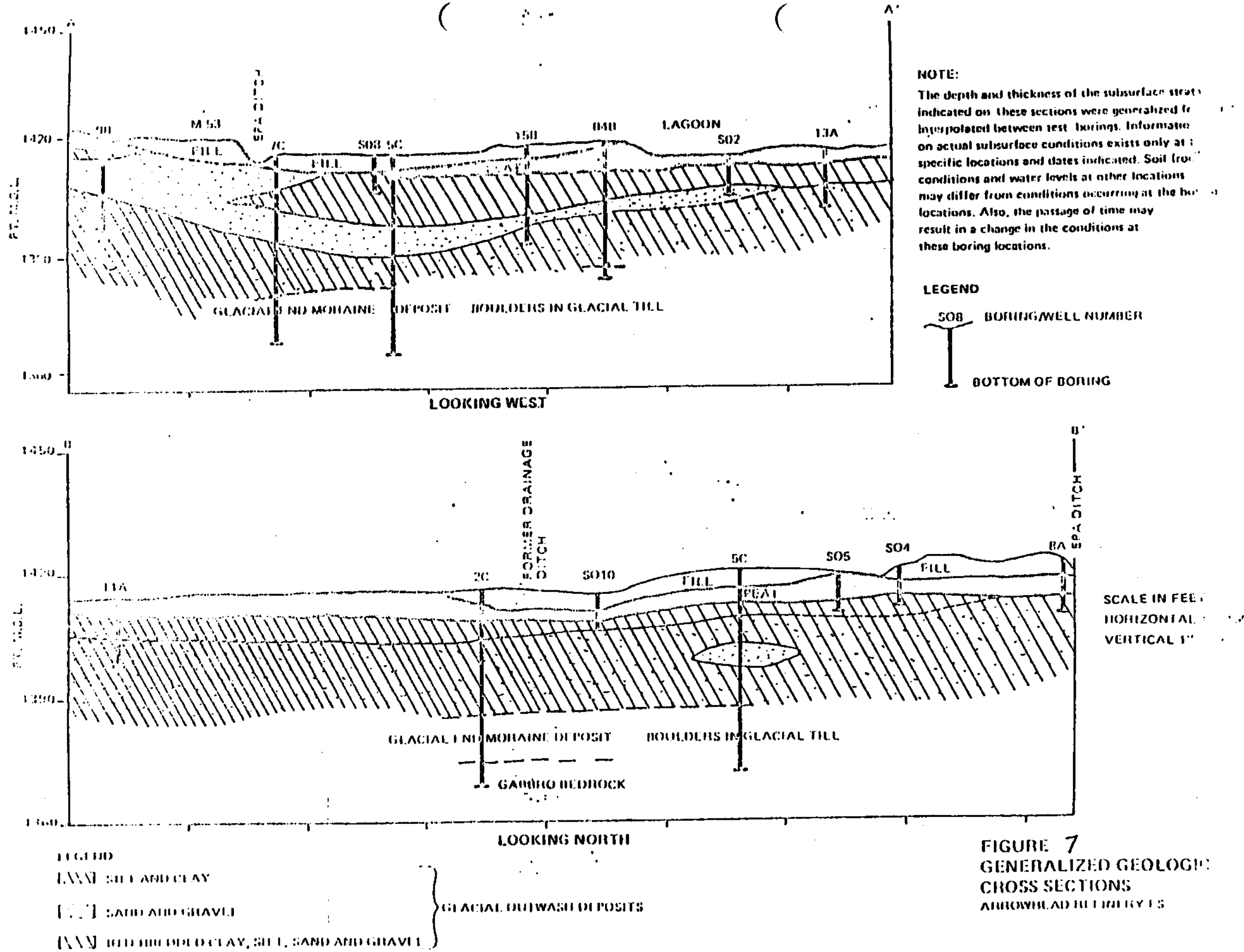


FIGURE 7
GENERALIZED GEOLOGIC CROSS SECTIONS
ARROWHEAD REFINERY ES

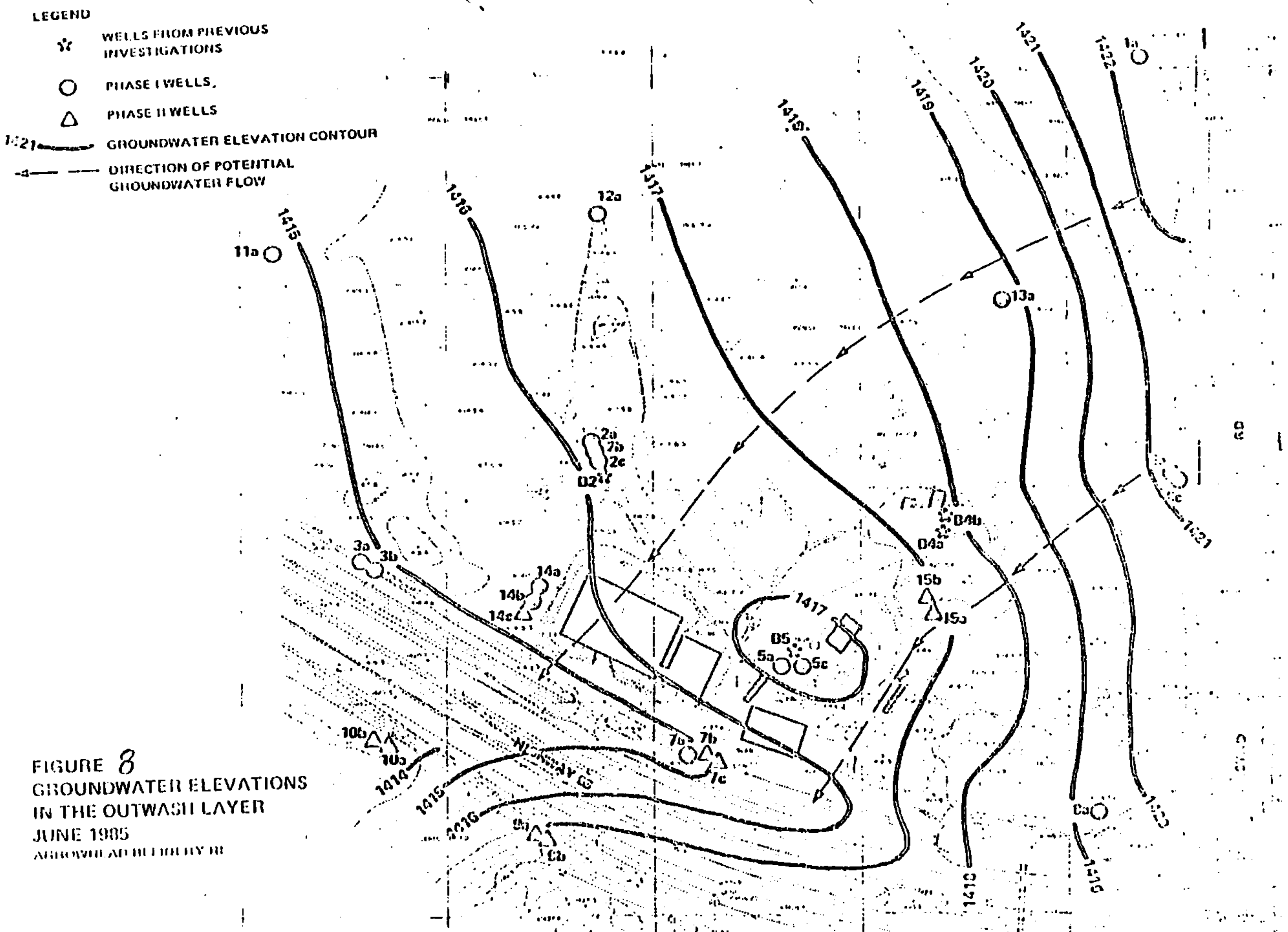


FIGURE 8
GROUNDWATER ELEVATIONS
IN THE OUTWASH LAYER
JUNE 1985
ARROWHEAD REFINERY RI

Contamination by media is not defined in this Record of Decision as contaminant concentration above background, but is defined as the concentration of at least one contaminant at a level known to cause cumulative excess lifetime cancer risks exceeding 10^{-6} in a commercial/industrial setting and/or exceeding the adult chronic acceptable intake (AIC) for noncarcinogens. The major compounds and concentrations that correlate to the contamination criteria are presented as part of Tables 1 and 2. The major chemicals of concern at the site with regard to public health impacts are Volatile Organic Compounds (VOCs), Polynuclear Aromatic Hydrocarbons (PAHs) and lead. The VOCs of greatest concern in all media are benzene, carbon tetrachloride, chloroform, trans-1,2-dichloroethene, trichloroethane, and vinyl chloride. All of these chemicals except trans-1,2 dichloroethene are potential human carcinogens by both the ingestion and inhalation routes. Trans-1,2-dichloroethene is the most common organic chemical in the groundwater. While it is not carcinogenic or thought to be highly toxic, it can degrade in water under these site conditions to vinyl chloride, which is a carcinogen and highly toxic.

PAHs are a group of chemicals found in the soil and sediment of the site. They are persistent and relatively immobile. PAHs were not found in groundwater at detection limits of 10 parts per billion (ppb). While only one PAH, benzo (a) pyrene, is included in the quantitative risk assessment, six other PAHs that are present in soil and sediments

Table 1
COMPARISON OF GROUNDWATER CONCENTRATIONS TO STANDARDS, CRITERIA, AND GUIDELINES
ARROWHEAD REFINERY SITE

Chemical Name	Maximum Reported Concentration ug/l	Safe Drinking Water Act Interim Maximum Contaminant Limit (MCL) ug/l	Safe Drinking Water Act Proposed Maximum Contaminant Limit (MCL) ug/l	Safe Drinking Water Act Secondary Maximum Contaminant Limit (MCL) ug/l	Safe Drinking Water Act Recommended Maximum Contaminant Limit (RMCL) ug/l	Clean Water Act Water Quality Criteria (AWQC) for Human Health Adjusted for Drinking Water Only (ug/l)		Safe Drinking Water Act Health Advisories - (ug/l)						
								1 day		10 day		Chronic		Lifetime
						Toxicity Protection	Cancer Risk @ 10^{-6}	10-kg Child	70-kg Adult	10-kg Child	70-kg Adult	10-kg Child	70-kg Adult	70-kg Adult
Arsenic	877	50			50P		0.0025	50		50		50	50	50
Barium	660	1,000			1,500P									1,800
Benzene	82		5		0F		0.67	233		233				
Beryllium	33						0.0039							
Bis(2-ethylhexyl)Phthalate	66					21,000								
Cadmium	222	10			5P	10		43		8		5	18	18
Chromium	290	50			120P			1,400		1,400		240	840	170
Copper	523			1,000	1,300P	1,000								
Cyanide	41					200		220		220		220	750	750
Dibutylphthalate	10					44,000								
1,2-Dichloroethane	7		5		0F		0.94	740		740		740	2,600	
1,1-Dichloroethene	25		7		7F		0.0033	1,000		1,000		1,000	3,500	350
Trans-1,2-Dichloroethene	3,500				70P			2,720		1,000		1,000	3,500	350
2,4-Dimethylphenol	100					400								
Dimethylphthalate	18					350,000								
Di-n-butyl Phthalate	10					44,000								
Ethyl benzene	57				680P	2,400		21,000		2,100				3,400
Iron	3,800,000			300										
Lead	722	50			20P	50						10	10	10
Manganese	84,000			50										
Mercury	0.22	2			3P	10								5.5
Methylene Chloride	42						0.19	13,300		1,500				1,750
4-Methylphenol	400					0.10								
Nickel	1,280					15.4				1,000				350
Phenol	400					3,500								
Pyrene	10						a							
Silver	266	50				50								
Toluene	300				2,000P	15,000		18,000		6,000				10,800
Trichloroethene	650		5		0F		2.8							
Vinyl Chloride	720		1		0F		2	2,600		2,600		13	46	
Xylenes	230				440P			12,000		7,800		78,000	27,300	2,200
Zinc	295,000			5,000		5,000								

[a]The Ambient Water Quality Criteria lists 0.0031 ug/l as the criterion for all polynuclear aromatic hydrocarbons (PAH's).
P = Proposed
F = Final

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Table 2
SOIL (SEDIMENT) CONCENTRATIONS AT WHICH CRITERIA OR RISKS COULD BE MET AT THE ARROWHEAD SITE

Chemicals	Concentrations in mg/kg Based on Potency Derived Cancer Risks as 10^{-4}		10^{-6}		10^{-7}		Concentrations in mg/kg Which Exceed the AIC for 10-kg Child at Soil Ingestion Rates of			Concentrations in mg/kg Which Exceed the AIC for 70-kg Adult at Soil Ingestion Rates of 0.1 g/day
	Risk levels based on a LASI[a] of									
	0.013	0.00029	0.013	0.00029	0.013	0.00029	0.1 g/day	1.0 g/day	10.0 g/day	
Benzene	170	7,700	1.7	77	0.17	7.7				
Benzo(a)pyrene	0.6	30	0.006	0.3	0.0006	0.03				
Carbon Tetrachloride	57	2,700	0.57	27	0.057	2.7				
Chloroform	116	8,000	1.1	50	0.11	5.0				
Tetrachloroethene	150	6,800	1.5	68	0.15	6.8				
1,1,2-Trichloroethane	130	6,100	1.3	61	0.13	6.1				
Trichloroethene	680	32,000	6.8	320	0.68	32				
Barium							5,100	510	51	35,700
2-Butanone							4,600	460	46	32,200
Cadmium							29	2.9	0.29	200
Carbon Disulfide							11,000	1,100	110	77,000
Chlorobenzene							2,700	270	27	18,900
Chromium							500	50	5	3,500
Copper							3,700	370	37	25,900
Cyanide							2,000	200	20	14,000
1,1-Dichloroethane							12,000	1,200	120	84,000
Ethyl benzene							9,700	970	97	67,900
Lead							140	14	1.4	980
Manganese							22,000	2,200	220	154,000
Mercury							28	2.8	0.28	200
Nickel							10,000	1,000	100	70,000
Toluene							29,000	2,900	290	200,000
Xylene							1,000	100	10	7,000
Zinc							21,000	2,100	210	147,000

[a]Based on lifetime average soil ingestion (LASI) of 0.013 and 0.00029 g/kg body weight/day for a 70-year lifetime. Includes a correction to account for climatic limits on exposure.

AIC = Acceptable intake chronic. The 10 g soil/day represents the intake of a "pica child," the extreme intake situation. The 0.1 and 1.0 g soil/day intakes are probably more representative of young children.

are also considered to be carcinogenic. Lead can be found throughout the site: in sludge, in the soils, and in the groundwater. It is present in levels which exceed acceptable human daily intakes. Lead affects both the nervous system and the hematopoietic (blood forming) system. Children are especially susceptible to lead exposure.

Sludge Lagoon

The RI estimates that there are 4,600 cubic yards of petroleum-based oily sludge which contain various organic compounds in the low part per million (ppm) range and high concentrations of heavy metals. The sludge also has a high energy value, low ash content, and is a very corrosive (pH = 1). Average lead concentrations are at least 4,700 ppm and range as high as 14,000 ppm. Average Polychlorinated Bi-Phenyl (PCB) concentrations are 2.4 ppm and range as high as 45 ppm. The entire sludge lagoon is considered contaminated.

Soil and Sediments

The RI estimates there are 14,300 cubic yards of contaminated soil that exceed the 10^{-6} excess lifetime cancer risk and the adult AIC. The areal extent of contamination, shown on Figures 9 and 10, is thought to be limited to the process area. The maximum depth of contamination is approximately 12 feet and is limited to the fill, peat, and upper five

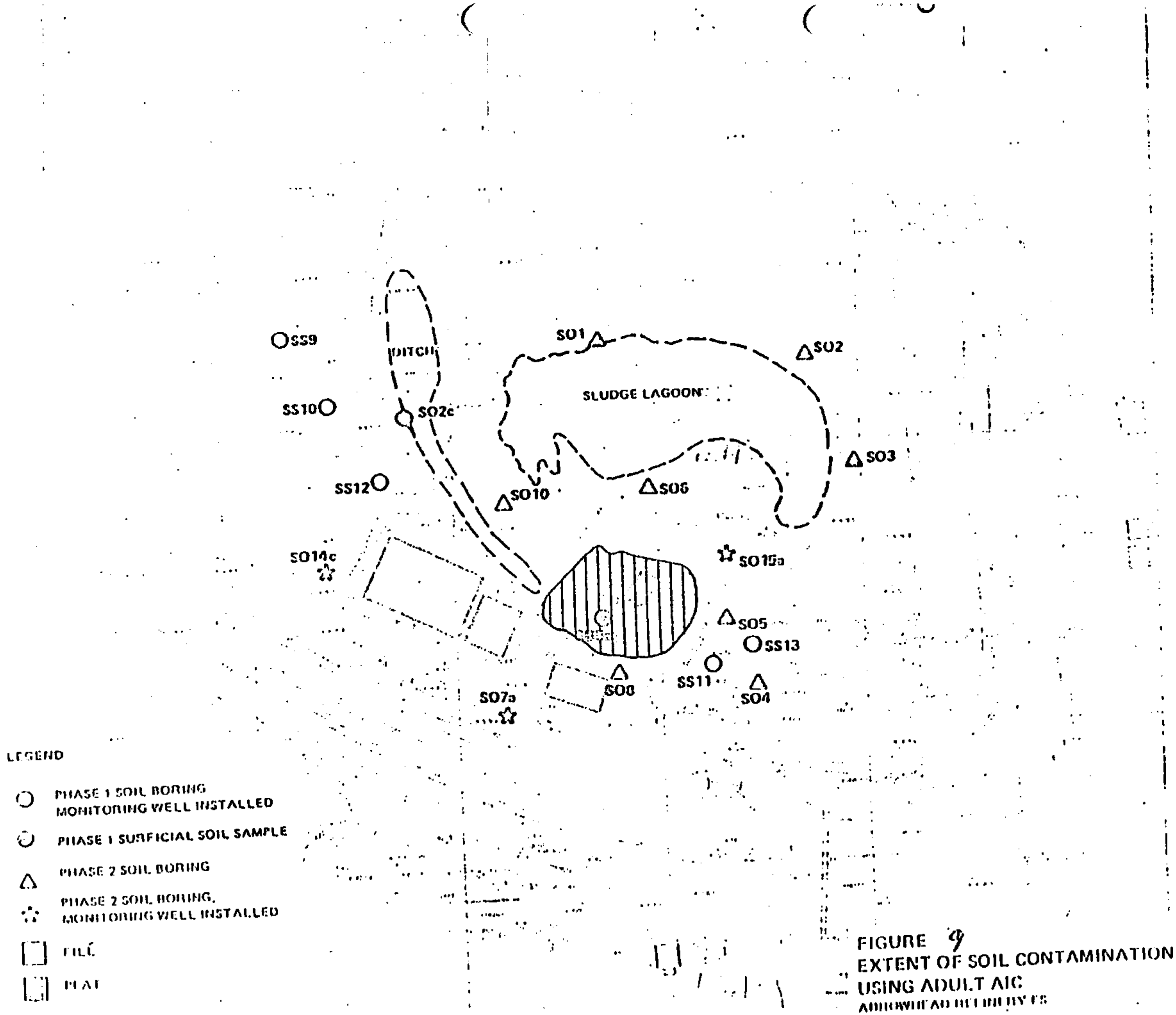

FIGURE 9
EXTENT OF SOIL CONTAMINATION
USING ADULT AIC
ARROWHEAD REFINERY FS

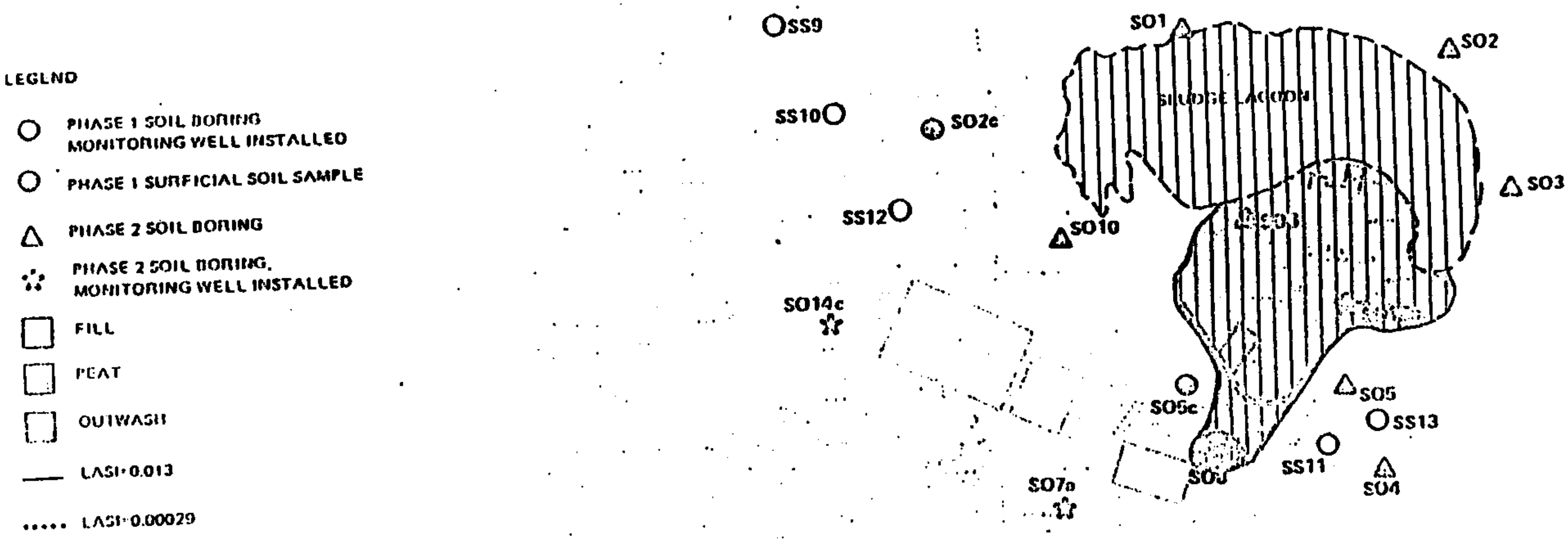

FIGURE 10
EXTENT OF SOIL CONTAMINATION
USING 10^{6} LIFETIME CANCER RISK
ARROWHEAD REFINERY FS

feet of outwash. The presence of the peat layer appears to be limiting downward contaminant migration because contaminants are much more concentrated in the peat when compared to the outwash layer.

The extent of sediment contamination is shown on Figure 11. Contamination appears to be limited to the wastewater ditch and the western portion of the diversion ditch. The volume for sediments is estimated to be 350 cubic yards, based on excavation to a depth of 1 foot. The sediments found in the diversion ditch south of to U.S. 53 are contaminated above background levels, but the concentrations are below the 10_{-6} lifetime cancer risk criteria for contamination.

Surface Water

Five volatile organic and several inorganic compounds were identified in surface water samples within the wastewater ditch that exceed 10^{-6} cancer risk levels and AIC for noncarcinogens. No contaminants were found in the surface water within the diversion ditch. Surface water run-on to the site has been controlled by the construction of the diversion ditch. The unusual occurrance of volatiles in the wastewater ditch may indicate significant contaminant runoff from onsite soils and sludge. The low levels of contaminants found in monitoring wells west of the wastewater ditch may indicate contaminant discharge through groundwater into the wastewater ditch. Thus, the wastewater ditch may

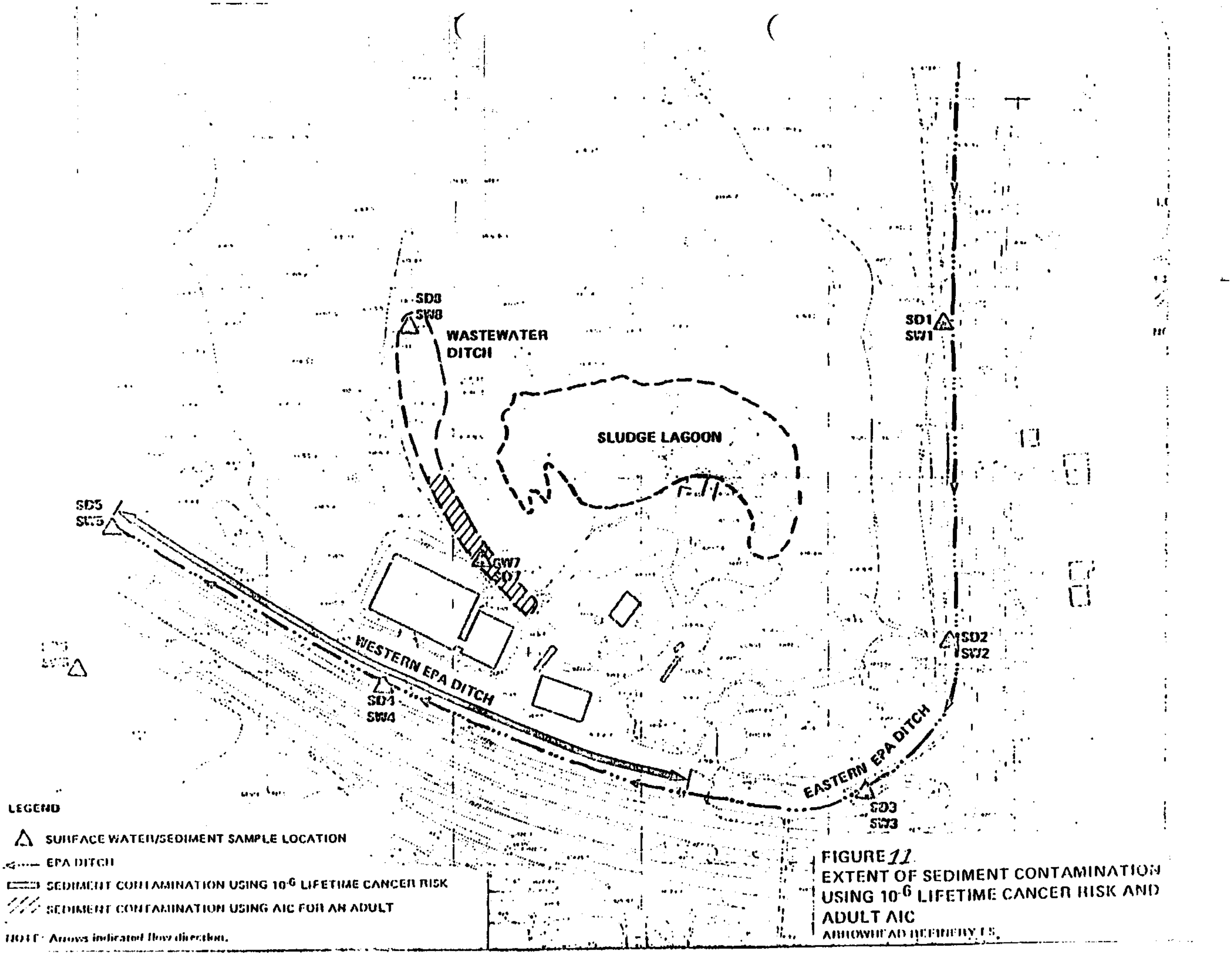

FIGURE 11
EXTENT OF SEDIMENT CONTAMINATION USING 10^{-6} LIFETIME CANCER RISK AND ADULT AIC
ARROWHEAD REFINERY I.S.

be a partial barrier for groundwater contamination west of the site.

Groundwater

Contaminated groundwater that exceeds the 10^{-6} excess lifetime cancer risk and AIC for adults is presented by soil layers in Figure 12 using Contract Lab Program (CLP) data. Throughout the project the MPCA split a selected number of monitoring wells samples. Because MPCA labs analytical methods have lower detection limits than standard CLP analysis, MPCA's results indicate benzene above 10^{-6} excess lifetime cancer risk in offsite wells 9 and 10. Although this MPCA data has not been quality assured by the U.S. EPA, it may indicate a greater area of off-site contamination. The discrepencies between MPCA and CLP data were taken into consideration during the evaluation of alternatives in the Feasibility Study (FS). Most of the contaminant mass appears to be concentrated near the sludge lagoon, within the process area and where an underground tank was recently excavated, approximately 20 feet north of monitoring well 7. The peat layer appears to be attenuating most contaminants, and thus has limited downward contaminant migration into the outwash. However, some contaminants mainly VOCs, have broken through the peat layer or have entered the outwash layer where the peat layer is not present.

A limited number of nearby residential wells within 1/2 mile of the site that may use groundwater from the same outwash and bedrock formations found at the Arrowhead Refinery site have been sampled

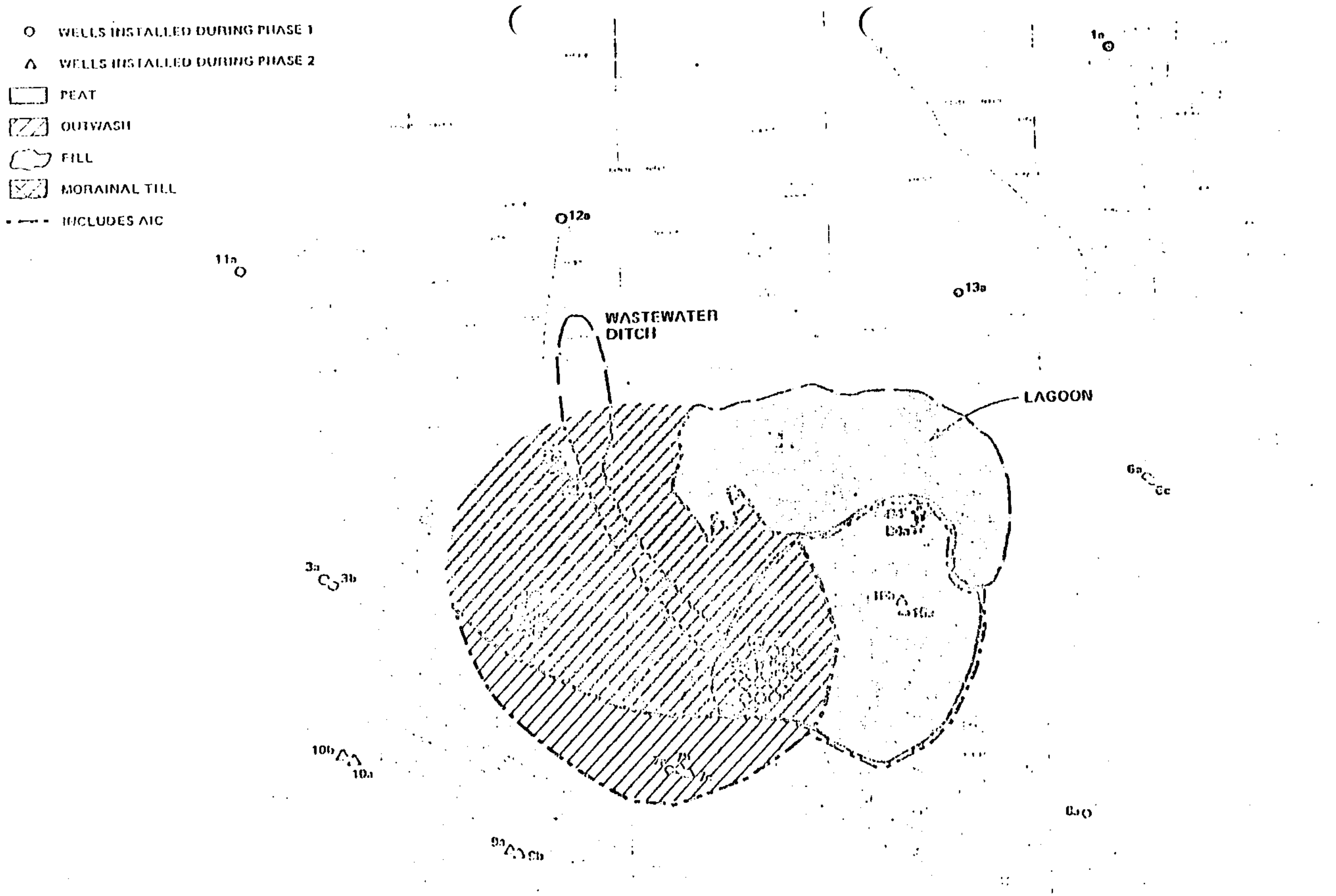

FIGURE 12
EXTENT OF GROUNDWATER CONTAMINATION
USING 10^{-6} LIFETIME CANCER RISK
AND ADULT AIC
ARROWHEAD REFINERY [illegible]

periodically by U.S. EPA and MPCA since 1980. All residential well results to date indicate no site related contamination.

RISK TO RECEPTORS VIA PATHWAYS

Sludge Lagoon

The sludge lagoon is a major contaminant source for continued future releases into groundwater, and also constitutes a public health threat by direct contact through touch or ingestion. Lateral movement of groundwater through the sludge lagoon and subsequent leaching of contaminants into the outwash layer makes the sludge lagoon a major source. Thus, either remedial action that contains and hydraulically isolates the lagoon or a removal action is necessary.

Soil And Sediments

The soil in the fill and peat layers poses a threat to public health and welfare by onsite exposures (ingestion resulting from outdoor activities, inhalation of particulates or volatiles, and dermal absorption) or contaminant migration (intermediate transfer by dissolution into groundwater). Potential soil ingestion under a commercial/industrial setting may result in an excess lifetime cancer risk as great as 4×10^{-5}. Should the site ever be developed for residential purposes, the excess cancer risk from soil ingestion could be as great as $3X10^{-3}$. Onsite soils also exceed the AIC for lead in a commercial setting and for a number of compounds such as lead, cadmium, xylene and barium in a residential setting. Lateral movement of groundwater through the contaminated fill and peat could be leaching contaminants into the outwash layer.

Exposures to surficial soils via air borne particles are unknown but appears to be limited because an oil coating hinders migration. Surficial soil runoff to the diversion and wastewater ditches adds to sediment contamination. Sediment contamination may also be due to groundwater discharge. Remedial action is necessary on the soil and sediments in order to remove existing and future endangerment to public health and the environment. Alternatives that either contain, remove, and/or hydraulically isolate soil and sediments have been evaluated for this site (see Alternatives Evaluation). Sediments will be consolidated into the same remedy as soils.

Surface Water

As described earlier, the wastewater ditch is contaminated with unacceptable levels of VOCs and inorganic compounds. The surface water remedy will be addressed as part of the groundwater remedy.

Groundwater

No onsite or offsite exposures to contaminated groundwater are known to exist to date. Nearby Gopher Oil and the auto body shop are reportedly serviced by the City of Duluth's water supply.

Onsite groundwater is considered unuseable. Potential ingestion of onsite groundwater has excess lifetime cancer risks as high as 10^{-2} regardless of whether onsite groundwater is used for residential or commercial/industrial purposes. The 1 day and 10 day Suggested No Adverse Response Level (SNARL) are also exceeded for various compounds. A groundwater flow and contaminant transport model was used to help predict future contaminant migrations and possible future contaminant concentrations in offsite receptor wells. Under assumptions made in this model, the results indicate that contaminants could reach the nearest offsite receptor within 15-40 years and at concentrations which could exceed the 10^{-2} excess lifetime cancer risk. This model is considered a worst case scenerio and may tend to underestimate contaminant travel times to a receptor. This model also does not account for any potential natural discharge barriers such as the diversion ditch or wetlands which may tend to hinder offsite contaminant migration.

Offsite contaminant migrations may already be occurring that pose a future threat to the environment and public health. Groundwater remedies that could possibly mitigate these threats have been evaluated for this site (see Alternatives Evaluation).

ENFORCEMENT (Attachment A) (CONFIDENTIAL)

ALTERNATIVES EVALUATION

In response to the health threats identified by the RI, a Feasibility Study (FS) was prepared to evaluate remedial alternatives at the Arrowhead site. The FS evaluates, assembles, and screens out alternatives consistent with the requirements of the National Contingency Plan (NCP).

Technology Screening

General response actions were identified for each contaminated medium: the soil, groundwater and sludge lagoon. Within each general response action, specific technologies were screened. Technologies use is clearly precluded or limited by site conditions and waste characteristics were eliminated from further evaluation. Similarly, the state of development is assessed for each technology. Included in these considerations were limitations such as implementation difficulties, inability to achieve the remedial objectives at this particular site, and undemonstrated performance of the technology.

Those technologies considered applicable were then evaluated using the guidelines set forth by the NCP (40 CFR 300.68(g)). Each technology was screened using three broad criteria:

- Acceptable Engineering Practices: Alternatives must present a technically applicable and reliable means of addressing the project goals. The alternative technologies should have a demonstrated performance record for the specific application, and be easily, safely, and readily implementable.

- Effectiveness: Alternatives that do not effectively contribute to the protection of public health and welfare and the environment are not considered further. If an alternative has significant adverse effects, very limited environmental benefits, limited useful life, or requires an excessive period of time to achieve beneficial results, it is excluded from further consideration.

- Cost: For each alternative, the cost of implementing the remedial action, including operation and maintenance costs, is considered. Alternatives whose costs far exceed the costs of other alternatives evaluated, and which do not provide substantially greater public health or environmental protection, or technical reliability are excluded from further consideration.

Those technologies that survived this screening were then asssembled into comprehensive remedial action alternatives that address each contaminated medium at the site. The FS documents the screening of technologies. Some common technologies carried forward for other sites but not the Arrowhead site include:

Offsite incineration - Eliminated on basis of preliminary cost estimates as compared to onsite incineration and from uncertainties that a facility will be readily available to accept Arrowhead waste.

Fluidized Bed Reactor - Not demonstrated for heterogeneous soils and full scale incineration of hazardous waste.

Multi-Layer Cap - Eliminated due to site conditions (marshy area). Can only be effective if water table is hydraulically controlled. Would require maintenance over infinity.

Onsite landfill - Same as above.

Chemical Fixation - Although treatability studies were not performed, the long term effectiveness for this technology is not demonstrated for the array of organic compounds found in Arrowhead waste.

Cementation - Same as above.

DESCRIPTION OF ALTERNATIVES

The following briefly describes the remedial alternatives.

Alternative 1 - No Action

Under this alternative, no additional work of any kind would be done at this site. Groundwater monitoring and maintenance of the existing fence, drainage ditch, and monitoring wells would continue on a regular basis. Since remedial actions would not be taken at the site, the public health and environmental risks would be identical to those described in the public health assessment of the RI report. In summary, under no action, use or development of the site could result in negative health effects on people using the site as measured by comparison with standards, cancer risk estimation, and comparison to acceptable intakes. Development could result in exposure to contaminants (VOCs, PAHs and lead) in the groundwater and soil primarily through exposure by ingestion and inhalation. Currently, offsite exposures are not occuring, but a potential exists for contaminant migration to offsite receptors.

Alternatives 2a and 2b

Alternative 2 includes the disposal of sludge, containment of soil, and the removal and onsite treatment of groundwater (Alternative 2a) or the removal and disposal of groundwater (Alternative 2b). An estimated 4,600 yd^3 of oily sludge, oilsaturated peat, and filter cake would be neutralized and solidified prior to transport to a RCRA-permitted landfill for disposal. The soil with contaminant concentrations exceeding the 10^{-6} excess lifetime cancer risk and the adult AIC would be covered with a 2-foot layer of topsoil. Contaminated sediment would be removed and consolidated with the contaminated soil prior to covering. The groundwater would be collected by a combination French drain and extraction well system. The total estimated flow of 72 gpm from the groundwater extraction system would be treated onsite (2a) or discharged untreated to the sewer (2b).

Residential wells would be sealed and the existing water main would be extended to provide an alternative water supply.

Alternatives 3a and 3b

Alternative 3 includes the offsite disposal of both sludge and soil, and either onsite treatment of groundwater (3a) or offsite disposal groundwater (3b). The basic remedial response for the sludge is the same as in Alternative 2. In addition, the soil with contaminant concentrations exceeding the 10^{-6} excess lifetime cancer risk and adult AIC would be excavated and transported to a RCRA-permitted landfill for disposal. An estimated 14,300 yd^3 (in-place) of soil would be excavated from an area of 45,000 ft^2. In addition, about 6,100 yd^3 of peat underlying the sludge lagoon will be removed. The groundwater remedial response actions for Alternatives 3a and 3b would be similar to those of Alternatives 2a and 2b except that the extent of the French drain system would be revised based upon the amount of soil removed, and the extraction flow would only be 45 gpm. Residential wells would be sealed and the existing water main would be extended to provide an alternative water supply.

Alternatives 4a and 4b

Alternative 4 includes the thermal treatment of sludge, containment of soil, and either the removal and onsite treatmet of groundwater (4a), or the removal and disposal of groundwater (4b). Approximately 4,600 yd^3 of oily sludge, oil-saturated peat, and filter cake would be incinerated onsite over a period of less than 9 months of continuous operation. The containment of soil would be achieved in the manner described for Alternative 2. The remedial actions for groundwater in Alternatives 4a and 4b would also be the same as described for Alternatives

2a and 2b. Residential wells would be sealed and the existing water main would be extended to provide an alternative water supply.

Alternatives 5a and 5b

Alternative 5 includes the thermal treatment of sludge, disposal of soil and treatment of groundwater. The treatment of sludge would be achieved by incineration in the manner described for Alternative 4. Contaminated soil would be excavated and disposed of offsite as described in Alternative 3. The groundwater response actions would be similar to that of Alternatives 2a and 2b except that the extent of French drains would be revised based on the extent of soil removal. The extracted groundwater would be either be treated onsite to remove contaminants (5a), or discharged untreated to the sewer (5b). Residential wells would be sealed and the existing water main would be extended to provide an alternative water supply.

Alternatives 6a and 6b

Alternative 6 includes the onsite thermal treatment of sludge and soil and either the onsite treatment of groundwater (6a), or the offsite disposal of groundwater (6b). Under this alternative, both the soil and sludge would be excavated and incinerated on-site. Incineration of an estimated 4,600 yd^3 of sludge and 20,500 yd^3 of soil and sediment would be achieved over a period of less than 2 years. The remedial actions for the contaminated groundwater would be the same as described in Alternatives 2a and 2b except that the extent of the French drain system would be revised based upon the extent of soil removal.

The total extraction flow (45 gpm) would either be treated onsite for the removal of contaminants or discharged to the sewer untreated. Residential wells would be sealed and the existing water main would be extended to provide an alternative water supply.

CONSISTENCY WITH OTHER ENVIRONMENTAL LAWS

In determining appropriate actions at CERCLA sites, consideration must be given to the requirements of other federal environmental laws in addition to CERCLA. The NCP, except as provided in 300.68(i), requires selection of a remedy that attains or exceeds applicable or relevant and appropriate Federal public health and environmental requirements identified at the Arrowhead site. The impact of applicable or relevant environmental and public health requirements are summarized in Table 3.

Other environmental requirements considered in the Arrowhead Refinery selection and evaluation of alternatives include the closure and groundwater protection standards, and incinerator operation requirements under the Resource Conservation and Recovery Act (RCRA). Other considerations include the wastewater discharge requirements under the National Pollutant Discharge Elimination System (NPDES), the Hazardous and Solid Waste Amendments (HSWA) of 1984, U.S. EPA's "Procedures for Planning and Implementing Off-site Response Actions, May 6, 1986, and the provisions of the Clean Air Act relating to operation of an air stripper and incinerator.

Table 3 (Page 1 of 8)
COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE
LAWS, REGULATIONS, POLICIES, AND STANDARDS
FOR THE ARROWHEAD REFINERY ALTERNATIVES

Law, Regulation, Policy, or Standard	Source of Regulation	Applicability or Relevance and Appropriateness	Alternative Affected
FEDERAL			
Resource Conservation and Recovery Act (RCRA)	RCRA Subtitle C, 40 CFR 260	RCRA regulates the generation, transport, storage, treatment, and disposal of hazardous waste. CERCLA specifically requires (in Section 104(c)(3)(B)) that hazardous substances generated from remedial actions be disposed of at facilities in compliance with Subtitle C of RCRA.	Alternatives 2 through 6. U.S. EPA policy indicates that the excavation and removal of contaminated sludge or soil from a CERCLA site is considered an action that generates hazardous waste. Excavated sludge and soil to be shipped offsite, therefore, must be managed as hazardous waste.
RCRA Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	RCRA Section 3004, 40 CFR 264 and 265	Regulates the construction, design, monitoring, operation, and closure of hazardous waste facilities. Subparts N and O specify technical requirements for landfills and incinerators, respectively.	If the incinerator residues generated under Alternatives 4, 5, and 6 are determined to be nonhazardous wastes, they would be landfilled onsite. Otherwise the residues would be shipped to a RCRA-approved landfill for disposal. The specified design of the soil cap for the containment of contaminated soil under Alternatives 2 and 4 would not fully attain the RCRA closure requirements for management of disposal of hazardous waste. But the action would provide significant protection to public health and welfare and the environment as specified under a category IV alternative (CFR300.68f).

Law, Regulation, Policy, or Standard	Source of Regulation	Applicability or Relevance and Appropriateness	Alternative Affected
Interim RCRA/CERCLA Guidance on Non-Contiguous Sites and Onsite Management of Waste and Treated Residue	U.S. EPA Policy Statement March 27, 1986	If a treatment or storage unit is to be constructed for on-site remedial action, there should be clear intent to dismantle, remove, or close the unit after the CERCLA action is completed.	Alternatives 4 through 6. The onsite incinerator will be dismantled, and incineration facilities will be removed for closure following processing of Arrowhead Refinery waste. This FS assumes that the technical requirements of RCRA will be met.
Standards Applicable to Transporters of Hazardous Waste	RCRA Section 3003, 40 CFR 262 and 263, 49 CFR 170 to 179	Establishes the responsibility of offsite transporters of hazardous waste in the handling, transportation, and management of the waste. Requires a manifest, recordkeeping, and immediate action in the event of a discharge of hazardous waste.	Alternatives 2, 3, and 5. These alternatives may involve transport of contaminated sludge, soil and sediment to RCRA/TSCA disposal facilities.
EPA Administered Permit Programs: The Hazardous Waste Permit Program	RCRA Section 3005, 40 CFR 270, 124	Covers the basic permitting, application, monitoring, and reporting requirements for offsite hazardous waste management facilities.	Alternatives 2, 3, and 5. CERCLA requires that contaminated substances (sludge and contaminated soil) to be disposed of offsite, be taken to permitted and inspected hazardous waste management facilities in compliance with RCRA.
EPA Interim Policy for Planning and Implementing CERCLA Offsite Response Actions	50 FR 45933 November 5, 1985	Discusses the need to consider treatment, recycling, and reuse before offsite land disposal is used. Prohibits use of a RCRA facility for offsite management of Superfund hazardous substances if it has significant RCRA violations.	Alternatives 2 through 6. Requirements for selecting offsite storage, treatment, or disposal facilities apply to Alternatives 2, 3, and 5. Alternatives 4, 5, and 6 consider onsite thermal treatment (incineration) of contaminated soil and sludge, but offsite disposal of residues at a RCRA facility may be required.

Law, Regulation, Policy, or Standard	Source of Regulation	Applicability or Relevance and Appropriateness	Alternative Affected
Hazardous and Solid Waste Amendments of 1984 (1984 amendments to RCRA)	PL 98-616, Federal Law 71:3101, 40 CRF 264	The currently applied form of the "Land Disposal Ban" (effective May 8, 1985) prohibits the direct placement of any bulk or noncontainerized liquid hazardous waste in landfills. These rules will also restrict the landfilling of most RCRA-listed wastes by 1991 unless the U.S. EPA promulgates applicable treatment standards for these wastes (40 CFR 264.314).	Alternatives 2 through 6. If treatment standards are not promulgated, landfilling of "banned" waste would not be acceptable without a successful demonstration that land disposal is protective of public health and welfare and the environment. Incineration of soil or sludge (assuming it is to be managed as though it is a RCRA waste) may be the only applicable treatment method. The ongoing status of legislation and technical requirements related to the Land Disposal Ban must be considered during development and implementation of all remedial actions.
Toxic Substances Control Act (TSCA)	40 CFR Part 761	Applies to the disposal of liquid waste containing PCB concentrations at or greater than 50 ppm and PCB's that have migrated from the original source of contamination. PCB concentrations greater than 500 ppm must be incinerated in an incinerator that complies with 40 CFR 761.70. PCB's less than 500 ppm and greater than 50 ppm may be disposed of in a landfill that complies with 40 CFR 761.75.	Based on available data, PCB levels in the sludge and soil are consistently less than 1 ppm. Therefore, it is unlikely that any of the alternatives would be affected by TSCA in its present form.
Statement of Procedures on Flood Plain Management and Wetland Protection	Appendix A to 40 CFR 6, Executive Order 11988, and 11990	Requires federal agencies to avoid wherever possible adversely affecting flood plains or wetlands and to evaluate potential effects of planned actions in these designated areas.	Alternatives 2 through 6. Precautions will be taken to minimize the impacts on the wetlands. Since all alternatives include actions that will occur in a wetland, implementation of an alternative will include a wetland restoration element.

Law, Regulation, Policy, or Standard	Source of Regulation	Applicability or Relevance and Appropriateness	Alternative Affected
Clean Air Act (CAA)	40 CFR 1 to 99	Applies to major stationary sources that have the potential to emit significant amounts of pollutants such as NO_x, SO_2, CO, lead, mercury, and particulates.	Alternatives 4 through 6. These regulations would not apply to emissions from the incineration of sludge and soil. Regulations under CAA do not specifically regulate emissions from hazardous waste incinerators, but the facility would emit less than 250 tons per year of any pollutant and therefore not classified as a major stationary source. Is unlikely that Prevention of Significant Deterioration (PSD) provisions would apply to an onsite thermal treatment facility.
Safe Drinking Water Act Maximum Contaminant Limits (MCL's)	Safe Drinking Water Act, 40 CFR 141 through 143	The Interim MCL's are enforceable standards for ambient drinking water quality. Recommended, Proposed, and Secondary MCL's are also applicable as advisory drinking water standards.	Alternatives 1 through 6. Residential wells near the Arrowhead Refinery site would be tested periodically to ensure that these drinking water sources continue to meet applicable standards. Alternatives 2 through 6 are designed to protect existing drinking water sources from contamination.
National Environmental Policy Act (NEPA)	NEPA Section 102(2)(c)	CERCLA actions are exempted from the NEPA requirements to prepare an environmental impact statement (EIS) because US EPA's decisionmaking processes in selecting a remedial action alternative are the functional equivalent of the NEPA analysis.	Alternatives 1 through 6. The functional equivalent of a NEPA review is carried out in U.S. EPA's regulatory activities for CERCLA actions.

Table 3 (Page 5 of 8)

Law, Regulation, Policy, or Standard	Source of Regulation	Applicability or Relevance and Appropriateness	Alternative Affected
Intergovernmental Review of Federal Program	Executive Order 12372 and 40 CFR 29. (Replaces state and areawide coordination process required by OMB Circular A-95.)	Requires state and local coordination and review of proposed EPA-assisted projects. The EPA Administrator is required to communicate with state and local officials to explain the project, consult with other affected federal agencies, and provide a comment period for state review.	Alternatives 1 through 6.
National Pollutant Discharge Elimination System (NPDES) Permit	CWA Section 402, 40 CFR 122, 123, 125 Subchapter N	Regulates the discharge of water into public surface waters.	All "a" alternatives. These alternatives include discharge from the onsite water treatment facility to the U.S. EPA ditch and the Rocky Run.
Pretreatment Regulations for Existing and New Sources of Pollution	40 CFR 403 Subchapter N, FWPCA	Regulates the quality of water discharged into publicly owned treatment works (POTW).	All "b" alternatives. These alternatives include the discharge of water from the site to the Western Lake Superior Sanitary District POTW.
Toxic Pollutant Effluent Standards	40 CFR 129	Regulates the discharge of the following pollutants: aldrin/dieldrin, DDT, endrin, toxaphene, benzidine, and PCB's.	Alternatives 2 through 6. These pollutants are not expected to be present in the discharge from the onsite water treatment plant.
US EPA Groundwater Protection Strategy	U.S. EPA Policy Statement	Identifies groundwater quality to be achieved during remedial actions based on the aquifer characteristics and use.	Alternatives 2 through 6. The present extent of offsite groundwater contamination related to the Arrowhead Refinery pollution is limited. All action alternatives are designed to limit the migration of groundwater contamination. The groundwater treatment systems are designed to eventually achieve a potable groundwater source at the site. The expected time required for acceptable groundwater cleanup, however, varies from a minimum of 25 years to over 140 years.

Table 3 (Page 6 of 8)

Law, Regulation, Policy, or Standard	Source of Regulation	Applicability or Relevance and Appropriateness	Alternative Affected
Occupational Safety and Health Act (OSHA)	29 CFR 1910	Regulates working conditions to assure safety and health of workers.	Alternatives 1 through 6. This applies to all workers on the site property during excavations, construction, and operation of facilities
STATE			
Rules Regarding the Handling of Hazardous Waste in Minnesota	Minnesota Pollution Control Agency (MPCA) Solid and Hazardous Waste Rules: Minnesota Rules, Chapter 7045, Parts .0010 through .0430	Provides general classification of hazardous waste in the state, and establishes requirements regarding the generation of hazardous waste and the location, operation, and closure of hazardous waste facilities.	Alternatives 1 through 6. Provides rules for the operation of a hazardous waste facility. Would apply to all alternatives including the no action alternative.
State Hazardous Waste Site Permit	MPCA Solid and Hazardous Waste Rules: Minnesota Rules, Chapter 7045, Parts .0650 through .0700	All sites where hazardous wastes are handled may require permitting from the state.	Alternatives 1 through 6. Pertains to the application procedure, review, general and special conditions, and permit exceptions regarding hazardous waste in Minnesota. Implementation of alternatives may require permitting including the no action alternative because the site would have to be maintained as a hazardous waste site. The MPCA has indicated that it would determine the applicability of these permits to the various alternatives.
State Permit or License for Transport of Hazardous Waste	MPCA Solid and Hazardous Waste Rules: Minnesota Rules, Chapter 7045, Sections .0500 through .0570 and Parts .0850 through .0930	Transporters of hazardous waste are required to register with the U.S. EPA. The waste materials must be containerized, loaded, and secured according to the procedures outlined in these sections. Shipping papers must also be maintained as required.	Alternatives 2 through 6. Alternatives that call for offsite disposal of hazardous sludge, soil, ash, or incinerator residue must be implemented in accordance with these regulations.
Minnesota NPDES Permit	MPCA Water Quality Division National Pollutant Discharge Elimination System	Regulates point source discharges to surface waters of the state. Establishes terms for the receipt and main-	All "a" alternatives. Regulates the discharge from the onsite water treatment facility offsite [illegible]

Law, Regulation, Policy, or Standard	Source of Regulation	Applicability or Relevance and Appropriateness	Alternative Affected
Minnesota Water Quality Standards	MPCA Water Quality Division Classification and Standards for Intrastate Water: Minnesota Rules, Chapter 7050	Establishes minimum water quality criteria, and provides a classification of Minnesota surface water and groundwater resources.	All "a" alternatives. Discharges from the onsite water treatment facility must meet the necessary Minnesota water quality criteria.
Minnesota Wastewater Pretreatment Facility Regulations	Rules of the Water and Wastewater Treatment Operator Certification Council: Minnesota Rules, Chapter 9400	Establishes the bases for classification of wastewater treatment facilities and the state operating and maintenance requirements.	All "b" alternatives. These requirements apply to the operation of the Western Lake Superior Sanitary District POTW.
Minnesota Air Quality Standards	MPCA Air Quality Division Air Pollution Control Rules: Minnesota Rules, Chapter 7005, parts .0010 through .0180	Establishes minimum ambient air quality standards and general provisions for monitoring and enforcement.	Alternatives 4, 5, and 6. The alternatives involving incineration of the sludge and/or soil should meet the intent of these air quality standards.
State Permit for Discharge of Air Pollutants	MPCA Air Quality Division Air Pollution Control Rules: Minnesota Rules, Chapter 7005, parts .0200 through .0280	Permits are required for the incineration of more than 100 pounds per hour of any nonfuel items. The state may delegate permitting authority to local jurisdictions.	Alternatives 4, 5, and 6. Permits may be required for the alternatives involving incineration. The MPCA would have jurisdiction for permitting at the Arrowhead Refinery site and would dictate the appropriate permitting action according to the alternative selected.
Performance Requirements for Incinerators operated in Minnesota	MPCA Air Quality Division Air Pollution Control Rules: Minnesota Rules, Chapter 7005, parts .0600 through .0650	These rules pertain to the operating performances of new and existing incinerators in the state, and establish rules and procedure for performance testing.	Alternatives 4, 5, and 6. Incineration alternatives should comply with state performance standards for operation and maintenance of incinerators.
State Permit Requirements for Emissions in Prevention of Significant Deterioration (PSD) Areas	Clean Air Act, Part C; State Implementation Plans	A major source of air pollutants such as NO_x, SO_x, CO, hydrocarbons, lead, and particulates in PSD area must be permitted by the state and is subject to requirements applicable to PSD areas.	Alternatives 4, 5, and 6. Since the facility would not emit more than 250 tons per year of pollutants and is not located in a nonattainment area, PSD review is unlikely.

Law, Regulation, Policy, or Standard	Source of Regulation	Applicability or Relevance and Appropriateness	Alternative Affected
State Permit Requirements for Emissions in Nonattainment Area	Clean Air Act, Part D; State Implementation Plans	If a major source is in a nonattainment area for those pollutants for which it is a major source, it must comply with requirements applicable to nonattainment areas.	Alternatives 4, 5, and 6. The Arrowhead Refinery site is presently in an attainment area. The impact on the site's air quality attainment status should be considered as part of the implementation of all alternatives involving incineration.
LOCAL			
Western Lake Superior Sanitary District (WLSDD) Industrial Pretreatment Requirements	Industrial Pretreatment Ordinance, June 1985, Western Lake Superior Sanitary District	The Ordinance prohibits the discharge of effluent containing toxic pollutants in sufficient quantity to injure or interfere with any wastewater treatment process, constitute a hazard to humans or animals, create a toxic effect in the receiving waters of the system, or exceed the limitations set forth in applicable categorical pretreatment standards.	All "b" alternatives. Data on contaminant concentrations in the groundwater indicate that effluent to the sewage system under this alternative would comply with local pretreatment requirements. POTW officials have not indicated any reluctance to accept the wastewater given contaminant concentrations and discharge rate.
Local Operating Permit or License for Remedy	Zoning, building or fire code, or local licensing Laws	Obtain local permit or license approving construction of site facilities.	Alternatives 2 through 6. Local permits must be obtained for the construction of the landfill, incinerator, and water treatment facilities as required.
Local Approval of Use Permit	Local Building Code	Demonstration through presentation of evidence or onsite inspection that remedial action complies with the requirements of local health and safety laws and ordinances.	Alternatives 2 through 6. Building and construction permits would be necessary for the onsite landfilling, and the water treatment and incineration facilities.
Local Building Permits (includes electrical, plumbing, and HVAC)	Local Building Codes	Obtain permits for construction.	Alternatives 2 through 6. Building permits must be obtained for the onsite landfilling, water treatment, and incineration.

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In general, alternatives 3a, 3b, 5a, 5b, 6a, and 6b are considered to attain applicable or relevant and appropriate federal public health and environmental requirements. Alternatives 2a, 2b, 4a, and 4b meet the requirements of CERCLA in that they reduce the likelihood of present and future health threats but they do not fully meet the requirements of other environmental laws.

DETAILED EVALUATION OF ALTERNATIVES

Each alternative was evaluated using technical and environmental criteria, and a cost estimate was prepared. For the technical analysis, each alternative was evaluated on performance, reliability, and implementability. For the environmental analysis, each alternative was evaluated for compliance with applicable, or relevant and appropriate federal and state environmental laws and regulations, protection of public health and welfare, and effects on institutional concerns. The detailed cost analysis for each alternative includes estimates of operation and maintenance (O & M) costs, capital costs, replacement costs, and development of present worth includes the initial construction costs and the present worth of O&M costs and replacement costs. A summary of the results of the detailed analysis is presented in Table 4.

SELECTION OF REMEDY

The U.S. EPA selected a recommended alternative upon comparison of the alternatives and consideration of site-specific remedial action goals. Section 300.68(i) of the NCP requires the U.S. EPA to select the

		ALTERNATIVE 1 No Action		ALTERNATIVE 2A/B Sludge Disposal & Soil Containment		ALTERNATIVE 3A/B Sludge Disposal & Soil Disposal		ALTERNATIVE 4A/B Sludge Treatment & Soil Containment		ALTERNATIVE 5A/B Sludge Treatment & Soil Disposal		ALTERNATIVE 6A/B Sludge Treatment & Soil Treatment
TECHNICAL CRITERIA Performance Reliability Implementability	NA NA NA	Technical Analysis not applicable for the no action alternative.	+ − +	Sludge relocated to a controlled environment (RCRA facility). Direct contact with contaminated soil prevented, and contaminated groundwater collected and treated. [illegible]	+ + +	Sludge, sediment, and soil are relocated to a controlled environment (RCRA facility), and contaminated groundwater is contained. [illegible]	+ − −	Sludge is incinerated and organic contaminants are destroyed. [illegible]	+ + −	Sludge is incinerated and organic contaminants are destroyed. [illegible]	+ ++ −	[illegible]
INSTITUTIONAL CRITERIA Standards Permits Land use/zoning	−− + −	[illegible]	+ − +	Proposed action does not fully attain RCRA requirements for disposal of hazardous waste [illegible]	++ − +	Proposed action attains RCRA requirements for disposal of hazardous waste. [illegible]	+ − +	Proposed action does not fully attain RCRA closure requirements for management of a hazardous waste facility. [illegible]	+ −− +	Proposed action will attain RCRA [illegible]	+ − +	[illegible]
ENVIRONMENTAL CRITERIA Biological Public Use	−− −−	[illegible]	+ +	Removal of sludge, capping of soil, and groundwater removal [illegible]	+ +	Removal of soil and sludge [illegible]	+ +	Removal of sludge, capping of soil, and groundwater removal [illegible]	+ +	Removal of soil and sludge [illegible]	++ ++	[illegible]
PUBLIC HEALTH CRITERIA Short-term Long-term	− −−	[illegible]	− +	Short-term public health risks expected to be minimal. [illegible]	 +	Short-term public health risks expected to be minimal. [illegible]	− +	Short-term public health risks expected to be minimal. [illegible]	− +	Groundwater collection system would [illegible]	− ++	[illegible]
ORDER OF MAGNITUDE COST ESTIMATES (a) w/Groundwater Treatment Total Capital (b) Annual O & M Present Worth (c)		$2,000 (d) $22,000 $222,000		$7,700,000 $190,000 $11,000,000		$22,000,000 $160,000 $24,000,000		$18,000,000 $190,000 $20,000,000		$33,000,000 $160,000 $35,000,000		[illegible] [illegible] [illegible]
w/ Groundwater Disposal Total Capital (b) Annual O & M Present Worth (c)				$8,000,000 $160,000 $9,500,000		$22,000,000 $130,000 $23,400,000		$17,000,000 $160,000 $19,000,000		$33,000,000 $113,000 $34,000,000		[illegible] [illegible] [illegible]

KEY (See Appendix for details)

−− Extremely negative effects even with mitigation measures, capable of eliminating an alternative.

− Negative effects, but not strong enough or certain enough to be the sole justification for eliminating an alternative; or of only moderate significance.

0 Very little apparent positive or negative effect, but inclusion can be justified for some special reason; or no change from existing conditions.

+ A positive or moderately positive benefit.

++ An extremely positive benefit.

NA Not applicable.

NOTES:

(a) [illegible]

(b) Total Capital Costs include indirect cost for engineering services, legal fees, administrative costs and cost contingencies. [illegible]

(c) Total Present Worth Cost is based on a 30-year period and a 10 percent interest rate.

(d) Groundwater treatment does not apply to the No Action Alternative.

TABLE 4
DETAILED [illegible]
EVALUATION [illegible]

"cost effective remedial alternative that effectively mitigates and minimizes threats to and provides adequate protection of public health and welfare and the environment." The selected remedial action should attain or exceed applicable or relevant and appropriate federal public health and environmental requirements. In selecting the appropriate remedy from among the alternatives that will achieve adequate protection of public health, welfare and the environment, the Agency must consider cost, technology, reliability, administrative concerns, and their relevant effects on public health, welfare, and the environment.

It is the U.S. EPA's policy to pursue onsite response actions that use treatment, reuse, or recycling rather than land disposal to the greatest extent practical but consistent with CERCLA requirements for a cost-effective remedial action. This policy and the NCP require the U.S. EPA to consider the long term effectiveness of treatment, reuse, and recycling in comparing their frequently higher short-term costs to other alternatives with long-term costs and/or continuing liabilities such as land disposal.

Both the existing CERCLA statute and the selection framework in the current NCP provide for the consideration of technologies which can destroy or detoxify hazardous substances for maximum risk reduction. The NCP defines remedial actions as "those responses to releases that are consistent with permanent remedy" (40 CFR 300.68(a)), and the NCP preamble states that "the use of permanent solutions may be the most cost-effective response and should be encouraged " (50 FR 47929).

The use of alternative technologies that treat or destroy hazardous wastes is further encouraged by the 1984 Hazardous and Solid Waste Amendments (HSWA), the CERCLA Policy on "Procedures for Planning and Implementing Off-Site Response Actions" (issued May 6, 1985), and proposals for CERCLA reauthorization currently before Congress that give a strong preference to treatment/destruction options to provide permanent solutions to the maximum extent practicable. Overall this results in concern against disposal without treatment, either onsite or offsite.

The long-term effectiveness of alternatives was evaluated in NCP terms, that is, in assessing whether the technolgy "effectively mitigates and minimizes threats to and provides adequate protection of public health and welfare and the environment " (40 CFR 300.68(j)(1)). Long-term reliability of the remedy was analyzed in terms of the effectiveness of each technology over time. A desirable objective was to minimize the long-term management or maintenance requirement at the site (i.e., to attain a "clean closure" or "walkaway" status at deletion). The reliability/effectiveness assessment focused on a series of key factors including the following:

- Long-term uncertainties of land disposal
- Persistence, toxicity, mobility, and propensity of waste to bioaccumulate
- Short-term risks of treatment/waste handling
- Threats associated with off-site disposal

- Uncertainties associated with long-term O&M
- Reduction of mobility, toxicity, and volume of waste attainable via treatment

Land disposal or insitu containment of untreated highly mobile and toxic waste was analyzed critically given the possibility of long-term migration and the attendant potential for long-term operation and maintenance.

ALTERNATIVE COMPARISON

Alternative 1

The no action alternative is ineffective in preventing further contamination and does not mitigate or minimize the existing threats to public health and welfare and the environment. Chapter 6, Public Health Assessment of the RI, concludes that there is a potential for exposure of the public to contaminants from the site at levels that may adversely affect the public health and welfare. Therefore, remedial action is required to mitigate or minimize this exposure. Thus, the no action alternative is not appropriate and is not recommended by the U.S. EPA.

Alternatives 2, 3, 4, 5, and 6

Sludge Response. Alternative 2 and 3 include disposal of sludge in an offsite RCRA landfill, whereas the sludge response action in Alternatives 4, 5, and 6 is thermal treatment. Disposal of sludge in a

RCRA landfill is considered a technically effective means of controlling contaminants in the sludge. This disposal response action meets RCRA standards and achieves CERCLA goals, and significantly improves the potential future land use on the site. Although the long term reliability of this removal and disposal action as it pertains to the site is considered good, land disposal is not considered as reliable as incineration in the long-term because it does not permanently destroy contaminants.

Because RCRA land disposal only transfers the waste to a more controlled environment, the U.S. EPA policy has become more restrictive on landfilling. As regulations become more stringent, the availability of RCRA-approved disposal sites is expected to decrease. Cost estimates for the land disposal action are also sensitive to RCRA landfill availability. Currently, a very limited number of RCRA facilities comply with U.S. EPA's "offsite policy" requirements. Therefore few are eligible to receive CERCLA wastes.

Incineration of the sludge has clear advantages over disposal. The action will destroy (not simply transfer) organic contaminants, thus reducing the overall waste volume by 60% and mobility and toxicity of organics to zero. There are, however, disadvantages to incineration. Thermal treatment is effective for destruction of organics but not of metals.

Since there are metals particularly lead, in the sludge that are not likely to be destroyed by incineration, particulate emissions (in violation of our quality standards) as well as high metal concentrations in the ash are possible problems that will have to be addressed. Preliminary testing (preburns) and compliance with technical requirements of permits (e.g., air quality) will be required. If the metal content results in the ash being hazardous, additional treatment or disposal in an offsite RCRA landfill may be necessary. Finally, in view of these concerns, implementation time for incineration is expected to be greater than for removal and disposal.

The U.S. EPA believes that long-term environmental reliability and cost effectiveness are the most important factors to consider in selecting an alternative. Incineration is clearly more reliable than landfilling as a permanent remedy at this site, by virtue of the permanent destruction of organic contaminants that is achieved. In addition, cost estimates for disposal at a landfill are not appreciably less than incineration. Therefore, thermal treatment is selected over land disposal as the preferred response action for sludge, eliminating Alternatives 2 and 3.

Soil Response. In Alternative 4, contaminated soil and sediment are contained onsite, whereas in Alternatives 5 and 6, they are disposed of offsite and treated onsite, respectively. Containment of soil and sediment via capping serves only to minimize direct exposure and does not meet RCRA closure requirements. Leaching of contaminants from soil will continue, and an effective groundwater collection or alternative water supply system would be required to limit exposure via the groundwater pathway.

Because contaminant movement is slow, the long-term reliability of the groundwater collection system is of major concern. Without any soil removal, the collection system would have to operate for a period estimated to be greater than 100 years to restore the aquifer to acceptable concentration levels posing less than a 10^{-6} lifetime cancer risk.

The long-term reliability of this action is considered poor. If soil is removed, however, the long-term reliability of the groundwater extraction and treatment system may be significantly improved.

With the soil removed, it will be possible to place four additional extraction wells in the process area without dewatering layers of contaminated soil. This would decrease the amount of time needed to achieve a 10^{-6} lifetime cancer risk groundwater cleanup goal to 25-50 years of groundwater extraction and treatment. In view of increased long-term reliability, the soil removal action is retained over the soil containment action, eliminating Alternatives 2 and 4.

Because of the combination of offsite soil disposal and onsite sludge incineration, Alternative 5 is the most costly of all alternatives. The cost per cubic yard for thermal treatment decreases in Alternative 6 because the incinerator is already in place and has gone through preliminary testing and startup phases. A key assumption regarding Alternative 6, however, is that residues from incineration could be managed as nonhazardous substances. If these residues must be landfilled at a RCRA permitted landfill, the present worth of Alternative 6 could increase by as much as $6 million, (assuming transportation to a facility within 800 miles). In that case the difference in present worth between Alternatives 5 and 6 would be reduced. Because an onsite action having superior long-term reliability might be achieved at a lower cost (regardless of residue disposal), thermal treatment of soil is retained as the soil response action action, eliminating Alternative 5.

Alternative 6 (combined incineration of sludge and soil) is therefore retained as the selected sludge and soil response.

Groundwater Response. The U.S. EPA has determined that removal of contaminated groundwater until the aquifer is restored to 10^{-6} lifetime cancer risk levels is the preferred groundwater response. However, a decision on the exact method for treating the contaminated groundwater will be deferred pending further investigation of the two possible responses.

The possible response for the extracted groundwater have been referred to in this FS under the alternative subheadings "a" and "b" as follows:

- "a" - Onsite treatment and discharge to diversion ditch.
- "b" - Discharge to a municipal sewer for treatment at the Western Lake Superior Sanitary District (WLSSD) sewage treatment facility.

Disposal of groundwater to a publicly owned treatment facility (POTW) such as WLSSD is considered more reliable in the long term than onsite treatment. Although a POTW is typically not specifically designed to treat a wide range of contaminants and concentrations, EPA has recently established that activated sludge plants such as the WLSSD POTW are capable of treating a variety of contaminants at low concentrations. The high dilution factor, the established maintenance, monitoring, and operating procedures, the potential for monitoring for VOCs emissions at the POTW, and the practice of sludge burning all contribute to the high reliability of POTWs as a groundwater response action.

Environmental benefits of a discharge to WLSSD are considered to be superior at this site because, should the onsite treatment system fail, wetlands and receiving waters may be affected by the discharge of untreated water. Since both the environmental benefits and long-term reliability of POTW disposal are considered superior, discharge of contaminated groundwater to WLSSD is retained as the preferred response action for groundwater at this site. The POTW option is estimated to cost less than onsite treatment, and is considered much less cost-sensitive than onsite treatment.

While disposal of the contaminated groundwater to WLSSD is the preferred action, it cannot be implemented unless a number of institutional and technical requirements are satisfied. The main requirement is that WLSSD must formally accept the wastewater and meet state and federal guidelines. To date, the WLSSD officials have not indicated any reluctance to accept the wastewater given the anticipated contaminant concentrations and effluent discharge rate.

Alternatives 6a and 6b will be considered during the preliminary design of the remedial action. Additional data and pilot testing will be required to determine the level of water treatment needed. The U.S. EPA will then determine which of the two water treatment methods can or should be used.

COMMUNITY RELATIONS (See Attachment B)

U.S. EPA'S RECOMMENDED ALTERNATIVE

The conceptual configuration of U.S. EPA's recommended alternative, Alternative 6a/6b is shown on Figure 13 and described in detail in Chapter 5 of the FS. The alternative consists of these elements:

Sludge/Soil/Sediment Response

- Design and construction of an incinerator proven usable for thermal treatment of hazardous wastes. Design, permitting, installation, pilot testing, and startup are expected to take 3.0 to 4.5 years (Appendix E of the FS).
- Design and construction of an interim storage structure for incinerator feed. The structure will be used to stockpile incinerator feed (i.e., sludge, soil, sediment) for incineration during periods of inclement weather (cold weather may inhibit excavation activities). The structure will consist of prefab-

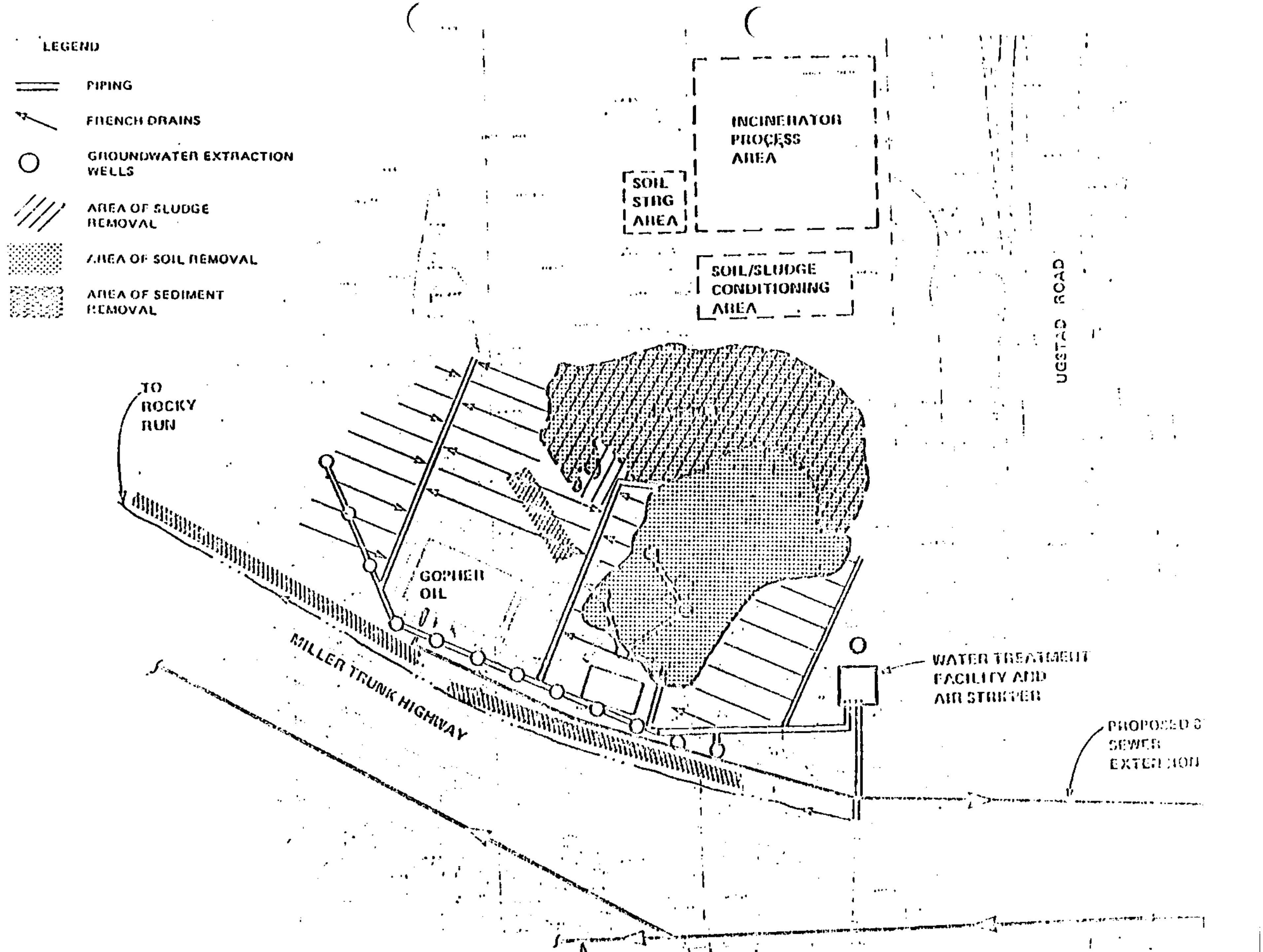

FIGURE 13
ALTERNATIVE 6a
ARROWHEAD REFINERY FS

ricated stell framework and walls, and a concrete floor sloped to channel leachate to a sump. Leachate would be pumped to the groundwater treatment facility, or discharged into the sewer for treatment at the POTW. Fugitive emissions of dust and VOC's would be collected and used as combustion air during incinerator operation and would be vented to the atmosphere during incinerator downtime.

- Removal and thermal treatment of the contaminated sludge in the lagoon, consisting of the oily sludge, oil saturated peat, and filter cake (4,600 yd3). Trees in the lagoon area would be removed and chipped. The exact method used for handling the sludge must be determined through pilot testing. For cost estimating purposes, this remedy assumes that the sludge could be excavated via mechanical means such as a backhoe, mixed with conditioning materials such as wood chips as necessary to produce a more easily handled material then conveyed to the thermal treatment facility or stored for future treatment.
- Removal and thermal treatment of soil and sediment containing contaminant concentrations exceeding the 10^{-6} excess lifetime cancer risk level and adult AIC levels (14,300 yd^3 of soil and 350 yd^3 of sediment). An additional layer of peat underlying the sludge would also be removed (6,100 yd^3). The 20,700 yd^3 of excavated soil and sediment would be trucked to soil conditioning equipment which would remove and/or reduce any

oversized materials. The soils or sediment would then be conveyed directly to the thermal treatment facility or stored for future thermal treatment.

- The resulting ash from the incineration of the contaminated sludge, soil and sediment would be placed onsite, provided it can be managed as non-hazardous material.

Groundwater Response

- Construction of a groundwater extraction system. A system of 2,600 feet of French drains and 16 extraction wells would be constructed. The extraction well system would consist of 12 wells situated downgradient of the excavated area, and 4 wells situated within the area from which the contaminated soil was excavated. The French drains would extract a total of 20 gpm, the 4 centralized wells would pump a total of 7 gpm, and the 12 downgradient wells would pump a total of 18 gpm.
- Groundwater treatment. The extracted groundwater would be treated in one of two ways under Alternative 6:
  a. An onsite water treatment facility would be constructed. The total extraction flow (45 gpm) would be treated. An air stripping tower would be used to remove 98 percent of the VOC's. Granular activated carbon filtration would remove base/neutral compounds, and lime precipitation would be used to reduce heavy metal concentrations. The treated groundwater would be discharged to the diversion

ditch, and the water treatment residue (sludge) would be disposed of at an offsite municipal landfill, assuming it can be managed as a non-hazardous waste.

b. The total extraction flow (45 gpm) would be discharged directly to the municipal sewer system. This would require the connection of a lateral from the groundwater collection pumphouse to the 8-inch-diameter sewer main bordering the highway. Based upon the estimated extracted groundwater concentrations of VOC's, PAH's and heavy metals, pretreatment would not be required to meet standards for discharge to WLSSD.

- Construction of groundwater monitoring wells. The cost estimate for Alternative 6 assumes construction and quarterly sampling of four new groundwater monitoring wells. The location of these wells will be determined during design.

- Extension of the existing water main westward to provide 10 residential service connections. Private wells would no longer be used by these residents.

DESIGN INVESTIGATIONS

According to the February, 1985 Superfund Remedial Design and Remedial Action Guidance, "remedial action involving the onsite treatment or disposal of contaminated wastes (i.e., groundwater, sludge lagoon and contaminated soils) may require additional studies to supplement the technical data available from the RI/FS activities so that the optimum treatment or disposal methods may be determined. Additional studies could include field work and/or bench and pilot scale studies. The fact that such studies will be performed should be explicitly addressed in the Record of Decision (ROD), and if necessary, the ROD should authorize the Region to make any necessary choice among treatment or disposal options".

In view of this guidance, the following predesign activities are recommended prior to implementation of the design and construction phases of the remedial action responses described above:

- Preburn on sludge and soil. Samples of sludge and soil should be thermally treated in a pilot-scale or full-scale unit. Results of this testing would indicate the likelihood of achieving applicable standards and criteria in a full-scale system operating onsite. Analysis of residues would indicate the need for further treatment necessary to manage them as nonhazardous materials. The major tasks anticipated in performing the preburn are listed in Appendix I of the FS.

- Aquifer testing. Pump tests should be conducted to better define parameters influencing design of the extraction system, e.g., permeability. The existing water table should be investigated further by piezometric measurements.
- Water treatment bench-scale/pilot study. Extracted groundwater will require testing to determine its compatibility with the onsite water treatment facilitiy or the WLSSD pretreatment standards. Agreements pertaining to discharge must be formalized

with WLSSD if the disposal option is used.

- In response to concerns raised by the State of Minnesota, technologies eliminated early in the FS will be evaluated in more detail. They include vitrification, chemical fixation, and cementation. Bench-scale studies will also be considered on these remedial technologies. The U.S. EPA agrees with the States concerns and believes that such evaluations will result in selection of the optimum treatment process.

- Sludge handling bench-scale/pilot study. The feasibility of mechanical excavation and alternative methods of removing sludge should be evaluated. The need for preconditioning of sludge prior to thermal treatment should also be assessed.

- Additional site investigations. Groundwater and soil sampling should be performed to better define the extent of contamination. If the onsite water treatment option is used, analysis of receiving streamflow should be done to determine the possible effects of the discharge.

- An incinerator siting investigation should be conducted to determine whether or not special foundations will be required to construct the incinerator onsite, and to identify any other access impediments.

Operation and Maintenance

Operation and maintenance (O&M) will be required for the groundwater extraction and treatment system for a period of 25-50 years if restoration of the aquifer to 10^{-6} lifetime cancer risk levels is to be achieved.

A schedule and type of O&M activities will be specified as part of the design phase.

Future Actions

The State of Minnesota may withhold concurrence with this remedy until the results of the predesign investigations are known. At this time, U.S. EPA feels there is enough information available to determine that removal and incineration of soil and sludge at the Arrowhead site is necessary. However, predesign investigations are necessary for the purpose of assuring that incineration is the optimum treatment process, and selecting the proper incinerator and refining the groundwater remedy (for example, the number, location, size, and pumping frequency of the groundwater extraction wells). The Feasibility Study documents that construction of a new onsite incinerator is more cost effective than shipping to an offsite hazardous waste incinerator or using a mobile incinerator. However, the use of incineration or other treatment technology is an application of a sophisticated process and will require special engineering considerations and studies. The use of offsite and mobile incineration and other treatment options will continue to be evaluated along with on-site incineration. Our final selection will be the option which will most efficiently treats Arrowhead waste at the least cost. In the event that information obtained during pre-design or design activities demonstrates that the costs of the selected remedy will exceed the estimates contained herein by more than 50%, the selected remedy will be reviewed, and if necessary, revised. In addition, if such activities show that a more cost-effective remedy is available which meets the objectives contained herein, this Record of Decision will be reviewed and revised as appropriate.

U.S. EPA will begin design and construction of the remedy upon assurance by the State of Minnesota of its commitment of the funds necessary to meet the statutory 10% state share of capital costs and O&M requirements. The State of Minnesota may concur that predesign investigations should be implemented, and based on the results of predesign activities, may eventually concur with our recommended alternative.

Assuming that CERCLA is reauthorized and design and construction funds are readily available, the duration for performance of the remedy at this site could be as follows:

SCHEDULE

Predesign Investigation	5 quarters
State Concurrence	Ongoing
Remedial Design	4 quarters
Construction	4 quarters
Operation	8 quarters
Incinerator Demobilization	1 quarter
Groundwater (pumping & treating)	25-50 years